# ANNALS of SURGERY

### A Monthly Review of Surgical Science and Practice

## TRANSACTIONS OF THE AMERICAN SURGICAL ASSOCIATION, 1931

## TRANSACTIONS

### OF THE

## AMERICAN SURGICAL ASSOCIATION

MEETING HELD IN SAN FRANCISCO, CAL., JUNE 29, 30, AND JULY 1, 1931

---

## ADDRESS OF THE PRESIDENT

### A STUDY IN RECORDS

By ALEXANDER PRIMROSE, F.R.C.S. ENG.

OF TORONTO, CANADA

THE American Surgical Association celebrated its semi-centennial last year. The transactions of this organization in the fifty years of its existence establish a record of achievement of which we are proud. We believe we have had a large measure of success in the attainment of those high ideals that are defined in the original constitution in these words: "The objects of the Association shall be the cultivation and improvement of the art and science of surgery and the promotion of the interests not only of its fellows but of the medical profession at large." Dr. Samuel D. Gross, recognized in the official record as the "founder" of the Association, and his associates, were men of broad vision who laid the foundation of an institution which has increased in influence and prestige and is now our rich inheritance.

While paying a tribute to the memory of the many fellows, no longer with us, who during their lifetime rendered such splendid service to this Association and contributed so greatly to its success, a reference may not be unfitting to certain living members. I cannot refrain from mentioning the name of that Nestor of the surgical profession on this continent, an international figure, Dr. W. W. Keen, of Philadelphia, the only surviving original fellow of 1880, who before his retirement accomplished so much to enhance the standing and reputation of this body. I may be permitted to name one other; I do so, in part, because he was my sponsor when my name came up for election in 1908; in part because I know of the high esteem and affection in which he was held by the older members who were associated with him throughout his active years. I refer to Dr. John F. Binnie to whom in his retirement we would wish to convey our greetings and our sympathy while deploring his enforced inactivity through prolonged illness.

Having regard to the past history of this Association and the authority it wields today in the surgical world, recognizing also the influence it exerts

in stimulating progress and in maintaining the highest ethical standards of our profession, I can conceive of no greater honor in surgery than to be elected its president. For thirty years the Association has extended the privilege of fellowship to Canadians, a privilege that has been highly valued. In fact today in Canada, as in the United States, membership in this Association is regarded as the "blue ribbon" for achievement in the surgical field. I thank my colleagues most sincerely for the confidence they have accorded me in placing me in the president's chair. I am conscious of the fact that my personal contribution to the activities of the society fail to merit this honor, but apart from this consideration I regard my election as a graceful mark of courtesy to my fellow Canadians among whom I am at present one of the senior living members.

The senior fellows of this Association form a privileged class. Our relationship to the Association as a whole might be described as *in loco parentis* carrying all the responsibilities of our station. Our function, I take it, is to encourage and stimulate a progressive spirit among our active members during that period of their professional career when opportunity, and the ability to grasp it, enables them to make important contributions to the advancement of the science and art of surgery. There may be a large element of truth in the sentiment of Burke that "the arrogance of age must submit to be taught by youth," but we may perform a useful function by utilizing our experiences in helping to assess the value of new discovery. "Experience, that excellent master," says Pliny, "has taught me many things." It is with some such consideration in mind I venture to refer to certain experiences in my own surgical activities.

Since the days of Hippocrates, clinical records have been preserved and have been studied with great interest and profit. The gradual evolution of medical science may be largely read in records coming down to us from antiquity, "records that defy the tooth of time." Many observations were recorded in illustration of knowledge laboriously accumulated regarding the healing of wounds and the return to normal of diseased and damaged tissues. A natural tendency for wounds to heal and for diseased organs to recover were among the facts early recognized. The *vis medicatrix naturæ* was a factor paramount in the remedial process. Ambroise Paré, the famous French war surgeon of the sixteenth century, quaintly expressed it by concluding his description of a successful case with the words, "I dressed him, God healed him." Again there is an ancient saying to the same effect: "Wounds have an insuperable tendency to heal."

One occasionally is impressed with the results that may be traced over a long period of years. The end results in surgery may be studied with great profit and for that purpose there is in operation in every well-equipped modern hospital a "follow-up system." It is a difficult undertaking and demands much labor and painstaking investigation. But such methods are

essential for the assessment of the true value of any specific form of treatment.

The term "end result" is seldom used in a sense that is strictly accurate. For example, we arbitrarily talk of a "five-year cure" in cancer of the breast, but there may be recurrence at a much later period. I have, in my own records, the history of a patient who suffered a local recurrence of cancer of the breast twelve years after the so-called radical operation for its removal, and of another who developed secondaries in the spine without local recurrence twelve years after removal of a mammary cancer. Nevertheless, we continue to make a comparative study of such statistics because of their value in estimating the results attained over a definite period by different forms of treatment.

Changes are constantly taking place in the tissues. In normal tissue we may assume that from the time of birth until death, changes occur continuously affecting both its chemical and morphological characteristics. Some of these changes are more obvious than others, for example, the deposition and the disappearance of adipose tissue, changes in the chemistry and cytology of the blood, etc. Where morbid states exist, the metamorphosis of the tissues is more obvious than is the case under normal conditions. When tissues are damaged by disease or trauma, the processes of repair become evident and have been studied with such precision that we can predict the various tissue changes that inevitably take place. In certain forms of cancer we note the tendency to the formation of fibrous tissue which, when in abundance, produces what we call "scirrhous cancer." This apparently is a defensive process which occasionally succeeds in holding the malignant process in check as in the so-called "withering scirrhus" of the breast. In tuberculosis again the deposition of fibrous tissue is of constant occurrence and we speak of the healing process in tubercle as "fibrosis." When a foreign body is introduced into the tissues, changes occur that result in encapsulation of the body by fibrous tissue or the removal of it by a process of absorption.

These observations lead one to speculate on other matters. For example, what do we mean by the term "early cancer"? I may illustrate once more from my records. Recently I operated upon a breast tumor that histologically was pronounced "early cancer." It was local in character, there being no lymph-glandular metastases. I find in my notebook I had examined that patient two and one-half years previously and had made a provisional clinical diagnosis of cancer. She arranged at that time for operation but postponed it because she had to nurse a sick mother. Was my early diagnosis correct? Has the growth remained more or less quiescent for two and one-half years? What are the beginnings and what is the progress of a cancer growth?

A few years ago while attending a conference on cancer, a surgeon from a German clinic informed us that in the aniline dye works in Germany workers suffered from a peculiar form of cancer of the bladder. He told

us that there were records of men who had been employed in such works for perhaps two years and had quit to take up other employment. Such men, ten or twenty years afterwards, presented themselves with the characteristic cancer of the bladder found in those working in aniline dyes. Archibald Leitch, of the Cancer Hospital, London, at the International Conference on Cancer in London (1928), stated that in cotton spinners, where cancer is produced by mineral oils, it has taken as much as sixty years to produce the result. He, however, attributed such results to the length of time of exposure to the noxious agent. These facts would suggest that what we are pleased to call "early cancer" may have been in existence for long periods, years possibly, before it has developed sufficiently to be recognized as a clinical entity. It has been suggested that the initial stages in cancer development may occur many years before a growth can be recognized. This hypothesis has been advanced to account for the fact that cancer rarely appears in early life and when it does appear early we always find the more rapidly growing type; it is very cellular, and is described as encephaloid with a minimum amount of fibrous stroma.

In 1920 I read a paper before this Association in which I described primary carcinoma of the appendix in two sisters both of whom were tuberculous. One had suffered from pulmonary tuberculosis and the other had a tuberculous Fallopian tube to which the appendix with its tumor, was adherent. In my paper I called attention to the fact that, in cases reported in the literature, tuberculosis and cancer of the appendix of the basal-celled type are frequently associated. I also cited a case reported by Barbour and Watson of a Fallopian tube that had been removed, showing histologically a typical picture of tubercle at one end of the tube and an equally typical picture of carcinoma at the other. I suggested that there might be some significance in this relationship between tuberculosis and cancer that had not been previously recognized.

Some twenty-five years ago Dr. Sampson Handley showed that cancer spread mainly by lymphatic permeation. He has recently published a paper in which he concludes from experimental and clinical evidence that lymph stasis plays an important rôle in the etiology of cancer. His statement is as follows: "My observations lead me to believe that the origin of cancer is intimately associated with local obstruction of the lymph-vessels in the area where the cancer arises." "To produce cancer," he adds, "the obstruction must be of long standing—must have lasted for twenty to thirty years." Sampson Handley observes that tuberculous processes tend to the production of lymph stasis and the sequence of events may be studied in certain forms of tubercle. Thus he cites, as an example, lupus erythematosus in which as a result of lymph stasis we may have papillary hypertrophy, definite papillomata and ultimately cancer. He quotes some interesting observations made by Dr. Thomas Cherry, of Melbourne, who ascertained statistically that, whereas during the last thirty years the death rate from tuberculosis has greatly diminished and that from cancer has greatly increased, the com-

bined death rate from tubercle and cancer together has remained at a constant level.

It is not contended by Sampson Handley that the tubercle bacillus is the only organism to produce chronic lymphangitis. The organism of syphilis or possibly members of the pyogenic group may produce lymphatic obstruction and may be potential cancer-producing agents.

Evidence has thus been adduced to suggest the probable relationship between tuberculosis and cancer, and the hypothesis is advanced that the cycle of changes necessary to produce a malignant growth after the initial lymphatic obstruction, is from twenty to thirty years.

In elaborating my theme I have been led to conclude among other things that certain morbid processes (*e.g.*, cancer) may have a long life history before they have sufficiently developed to produce a recognizable lesion. The fact that the metamorphosis of tissue may continue over long periods of time may be illustrated in the study of the process of repair after trauma and by analogy we may accept with greater readiness the thesis that many years are necessary for the development of carcinoma. Take for example fracture of a long bone. True the process of repair may proceed with sufficient rapidity to permit of restoration of function when sufficient stability has been acquired in the injured limb but the final result, in the complete restoration of the osseous architecture, with Haversian canals and the reproduction of the histologic structure of normal bone, is long postponed; probably these changes continue for years.

I may illustrate this progressive though slow-moving metamorphosis of tissue by reference once more to my personal records. These cases show that continued change may proceed over many years before a stable condition is reached.

Case I.—*After twenty years.*—In 1911 a man twenty-eight years of age fractured the proximal phalanx of the index finger of his right hand. The fracture had occurred through a fusiform tumor which occupied the entire shaft of the palanx. It proved to be an enchondroma. There were no giant cells present. The man, who was an accountant, was very anxious to preserve his finger and the operation which I performed was successful. After gouging out the tumor I introduced an ivory peg, 2.5 centimetres long and 3 millimetres thick and pointed at both ends. The wound was then closed. X-ray pictures were taken immediately before and after the operation. One was taken two weeks subsequently, another fourteen weeks from the time of the operation, a third after an interval of eleven years, and lastly when twenty years had elapsed.

These pictures show a progressive process apparently still active after twenty years. The foreign body is becoming more and more shadowy and possibly, if the patient lives long enough, the invader may be thrown out in its entirety.

Case II.—*After forty-five years.*—In 1909 I operated upon a woman sixty-three years of age for goitre. For the purpose of determining the degree of deflection of the trachea I had an X-ray picture taken of her neck before operation. I was greatly surprised to find a bullet embedded in the deep muscles. On enquiry I learned that when she was eighteen years of age she became involved in an *affaire de cœur* which did not progress smoothly and the young man shot her in the neck. The bullet was not extracted. It was discovered by me forty-five years afterwards.

The contour of the bullet appears unaltered and its edges are sharply defined (Fig. 1). Unlike the ivory peg described in my first case, this foreign body, composed of lead, remains unaltered in size and shape after forty-five years. The presence of such a non-absorbable body causes a tissue reaction that results in the formation of a



Fig. 1.—X-ray picture of a bullet embedded in the deep muscles of the neck for forty-five years (Case II).

fibrous capsule. The length of time that must elapse before the final stages of encapsulation are reached, have not been ascertained.

CASE III.—*After eleven and a half years.*—Under favorable conditions a graft of dead bone introduced into the tissues becomes absorbed and disappears. This fact is illustrated in the case of a man thirty years of age who had a large hiatus in the parietal

region of the skull, the result of a shrapnel wound received during the war in September, 1916. I attempted on February 11, 1919, to close the gap by introducing a piece of parietal bone from the cadaver. It was of large size, the actual measurements being 12 centimetres by 9 centimetres. In order to favor its vascularization I reamed off the inner table of the graft and penetrated it with numerous holes 3 millimetres in diameter and about 6 millimetres apart. The graft was then boiled and preserved aseptic. Finally it was introduced into the gap and the wound closed.

X-ray pictures were taken before the operation, showing the gap, and at various intervals thereafter, the intervals being seven days, three and a half months, thirteen months and finally eleven and a half years.

The bone graft entirely disappeared. The process of absorption continued for nearly a year before it was entirely complete. It is of interest to note that a small localized secondary infection occurred at a point where the tension on the scalp flaps impaired their vitality. The bone in this area failed to absorb and a small thin scale of bone 1.5 centimetres by 1 centimetre was cast off from the main graft like a sequestrum and removed as such.

This man's record suggests that progressive changes have occurred in the tissues at the seat of injury, extending over a period of years and are probably still active. His history states that at the time he was injured there was a considerable loss of brain substance with right hemiplegia and right hemianopsia. Spasticity of the arm and leg developed and later Jacksonian epilepsy. He also suffered from severe headache. The epileptic seizures ceased in 1921 (five years after the injury) and he no longer suffers from headache. This improvement is apparently accounted for by a progressive thickening that has occurred over the site of the hiatus affording much better support to the brain. The increased firmness on palpation is very noticeable. The X-ray picture shows that it is fibrous in character and not osseous.

CASE IV.—*After forty years.*—In 1889 a boy four years of age was admitted to the Hospital for Sick Children, Toronto, with a tuberculous spine. He had a kyphosis at the fourth lumbar vertebra and a psoas abscess pointing at the inner aspect of the left thigh. On January 18, 1890, I opened the abscess, using an aqueous solution of carbolic acid, of the strength of 1 in 20, as my antiseptic to prepare the skin surface and chloroform as my anæsthetic. The abscess was opened in the loin where bare bone was discovered on the anterior surface of the vertebral body. After evacuating the pus, the abscess cavity was flushed out with 1 in 5000 aqueous solution of per chloride of mercury. A drainage tube was introduced and a dressing of gauze soaked in 1 in 40 carbolic acid was applied. In October, 1890, I opened in the loin a psoas abscess that had developed on the right side. The antiseptic treatment was similar to that employed in the first operation.

This lad therefore suffered from Pott's disease of the lumbar spine with double psoas abscess. He remained in the hospital for three years and was discharged in good general health, his wounds were all healed and he was able to walk without support. Two years after his discharge he attended school like other boys and has remained in good health since that time. As he grew up he obtained employment, engaging in heavy manual labor; fifteen years as a farmer and subsequently in the employ of a transportation company. He married and has two healthy children.

Exactly forty years after my operation this man again came under my observation. He was interested in an appeal made by the Children's Hospital for funds and came to show himself as a successful product of hospital treatment. My colleague Dr. R. I. Harris examined him carefully and made the following notes:

Examination shows him to be a short stocky man, well muscled, and well nourished. The trunk is short and thick as the result of the destruction of the lumbar vertebræ. The lumbar lordosis is completely obliterated by a rounded kyphosis which passes smoothly into the segments of the spine above and below. There are two well-healed scars on either side of the spine, representing the healed sinuses. The ribs touch the

iliac crests. No abscess can be felt. Movements of the spine are remarkably free. The range cannot be distinguished from normal. Movement takes place in the lower lumbar segment, and the dorsal region. The central lumbar segment is rigid. He has no pain, and is able to perform heavy manual labor without difficulty.

The X-rays show the remnants of the bodies of four lumbar vertebræ, the second, third, fourth and fifth, are fused together in a solid bony mass (Fig. 2). There is no trace of intervertebral discs between these bodies, nor is there any indication of the individual bodies. The bony mass which represents the fused bodies is small, scarcely larger than a normal lumbar vertebra. The divisions are identified by the pedicles, the



FIG. 2.—Roentgen-ray of the lumbar spine, showing complete fusion of four vertebral bodies in a solid bony column, forty years after operating for double psoas abscess contingent upon a tuberculous spine (Case IV).

spinous processes and the intervertebral foramina. The foramina are normal in size and shape. The twelfth dorsal and the first lumbar vertebral bodies are normal.

It is impossible to estimate with accuracy the length of time that necessarily elapsed before the conditions found today, forty years after the primary treatment, were finally reached. We may safely assume that many years passed before complete fusion of the vertebral bodies and the reproduction of normal bone tissue occurred.

I have endeavored to demonstrate the fact that tissue change both in new growths and in the process of repair may continue over many years. This circumstance must have an important bearing on our diagnosis, prognosis and treatment.

# RECONSTRUCTIVE OPERATIONS FOR JEJUNAL ULCER

## By Donald C. Balfour, M.D.

### of Rochester, Minn.

CONSERVATIVE operations for chronic duodenal ulcer, in well-selected cases, hold a great advantage over radical operations because of the safety with which they can be performed. Discussions of the relative merits of conservative and radical procedures do not give this fact sufficient consideration, and are chiefly concerned with end-results. Admitting the possibility that recurrence of ulceration after partial gastrectomy is less likely than after operations in which the stomach is not resected, the increased operative mortality of primary partial gastrectomy, particularly if it is applied as a routine, will more than offset the increased liability of recurrent ulceration after conservative operations. Accepting, therefore, the fact that recurrent ulceration does occur in 2 or 3 per cent. of cases in which conservative operations have been done, a very important phase of the problem is the care of the recurrent lesion.

The care of jejunal ulcer presents two problems: The jejunal ulcer and the primary ulcer. The jejunal ulcer itself does not present great difficulties, provided operation is not unduly delayed. A positive diagnosis of jejunal ulcer justifies early surgical intervention. Under such circumstances, operation so far as the jejunal ulcer is concerned, is safe and satisfactory. Delay means danger of complications, hæmorrhage, perforation, colonic fistula and therefore increased technical difficulties, greater risk, and less prospect of an ultimate good result. The operation for jejunal ulcer requires at least removal of the ulcer and disconnection of the gastroenterostomy.

The next problem is that of the primary lesion. It is an excellent practice, in operating for jejunal ulcer, first to expose and investigate thoroughly the duodenum, pylorus, and stomach. In the occasional case no evidence of an inflammatory process can be found by such inspection, and the pylorus is patent. Under such circumstances the problem is already solved, for there is no remaining evidence of the indications on the basis of which gastroenterostomy had been performed. Usually, however, the primary lesion is found in the duodenum, and, to all appearances, has healed. Under such conditions, if the duodenum or pylorus is not deformed, and the lesion does not lend itself readily to excision, it may be wise to disregard the lesion and to attempt to prevent reactivation by a dietary regimen, and so forth. In most cases, however, it is advisable to carry out some surgical procedure for the primary lesion.

Operations for primary duodenal ulcer under such circumstances must be based on the fact that the patient has already exhibited high liability to recurrence. Since this is true, any operation involves the risk of recurrence;

therefore, those procedures which do not create serious technical difficulties, should recurrence take place, have very definite advantages. In this respect, excision of the primary lesion with reconstruction of the pyloric outlet is an excellent procedure and can be satisfactorily done much more often than is supposed. In some cases, partial gastrectomy is the operation of choice, and it is to the method of performing this that I wish to draw attention.

The first case in which I carried out the procedure to be described was that of a man aged thirty-nine years on whom I had already done two resections of the stomach for recurrent ulcer. The first resection had been an extensive one of the Polya type for jejunal ulcer but this was soon followed by symptoms of recurrence, for which resection was plainly necessitated. This was accomplished by a modified Hoffmeister-Roux procedure, but relief of symptoms was of short duration. Symptoms were more severe than at any previous time and disability was complete. The acidity of the gastic content was reduced to a point at which free hydrochloric acid was frequently absent. At operation an enormous ulcer involving the jejunum and adjacent portion of the stomach was found, the crater of which was about 3.5 centimetres in diameter. The infiltration of surrounding tissues and of the colon was most extensive. It seemed reasonable to doubt that control of the disease could be secured by repeating a procedure which had already failed twice, and it seemed desirable to unite, if possible, the fundus of the stomach and the duodenum. The portion of the jejunum which contained the ulcer and an adjacent segment of stomach were first resected *en bloc*, end-to-end anastomosis of the two resulting portions of the jejunum was done, and about half of the end of the stomach was closed. The duodenal stump had already been explored and I found it possible to mobilize it sufficiently so that anastomosis could be made between the open end of the stomach and the lateral wall of the duodenum. A catheter was introduced into the upper part of the jejunum, and was used for administration of fluids and nourishment for ten days. The patient recovered uneventfully and returned home in three weeks.

I have carried out this same procedure in two other cases, one a case of jejunal ulcer following partial gastrectomy, and the second a case of jejunal ulcer in which, at the first operation elsewhere, the duodenum had been completely divided, so that, with a small gastroenteric stoma, partially blocked, almost complete obstruction was present. In the three cases most satisfactory results followed, and it is reasonable to believe that the prospects of preventing recurrence are better than those following any previous procedure. The union of a resected stomach and the duodenum should carry with it all the advantages of full utilization of the alkaline juices of the duodenum, and thereby should reduce the liability of recurrent ulcer to a minimum.

DISCUSSION.—DR. J. SHELTON HORSLEY (Richmond, Virginia) said that he had had several cases of recurrences of this type and he had been using the technic which he showed in connection with operations for cancer of the stomach before this Association several years ago, where the stump of the stomach is brought to the duodenum along the lesser curvature, preserving the physical functions of the peristalsis; the end of the duodenum is split, flaring it open, in some instances flared open to make an end-to-end, and in other instances the lower portions of the curvature are tucked in.

In spite of this, however, he had had recurrences in two cases. One of them was a patient who had been operated on five times before Doctor Horsley saw him. He had a

very large ulcer at the junction of the stomach and the duodenum, and it had a chronic perforation. Doctor Horsley merely opened it and drained it. The patient died.

Another patient had also been operated on a number of times elsewhere before he was seen by the speaker, who resected and then tried the method recommended by Doctor Balfour, feeding through a jejunostomy tube for a long time. The patient wouldn't take it for more than three months. In spite of that Doctor Horsley was never able to get the gastric acidity very low, not more than about 20. The patient now has a recurrence, but he is improving under general medical treatment.

These cases with a tendency for recurrence of what might be called peptic ulcers are extremely puzzling. After all, while the general method of anastomosing the stump of the stomach to the duodenum is probably better than a re-anastomosing to the jejunum, one of the essential points is to give rest to the tissues. A fasting stomach still secretes some acid. Physiologists have shown that the acid is at the lowest possible point when fasting. As soon as food is put into the stomach it stimulates the activity and there is more gastric juice and a greater acidity. An important point, therefore, in these recurrent cases is to feed them by a jejunal tube for a period of months, or possibly a year or more.

The speaker said that in primary peptic ulcer of the stomach he usually did a modification of the Billroth i operation.

DR. DAVID CHEEVER (Boston, Massachusetts) reported the case of an individual who had a primary complete perforation, which was operated on in western Massachusetts and the patient's life saved. Then he had a gastrojejunostomy done, from which he recovered. There was a marked recurrence of the symptoms of ulcer. Then the speaker operated on him for the first time and did a resection of the pyloric antrum and a gastrojejunostomy. He did quite well for a while. Then he had serious symptoms, more serious than he had before, and developed a large gastrojejunal ulcer. At a second operation the whole thing was resected and the wide-open end of the stomach anastomosed to the lateral aspect of the second portion of the duodenum. That patient has done very well and has now gone a longer period of time than he ever went before without serious symptoms.

It is obvious that the pyloric function, or the pylorus as a whole, is done away with in such an operation, so any muscular action of the pylorus is entirely stopped. One might be tempted to think that the very intimate mixture of the contents of the duodenum with the stomach, through the large opening, might be the cause of favorable results, yet in Doctor Balfour's case he tells us that that particular individual had a minimum of free hydrochloric acid, so that one particular explanation doesn't seem to hold water. The fact remains, however, that perhaps this method is a better solution of the problem of handling intractable ulcers of the duodenum than those which have been heretofore employed, except, of course, the simple gastrojejunostomy which seems to be the accepted operation of choice for uncomplicated cases.

With regard to the ease of anastomosing a stump of the stomach to the duodenum, Doctor Cheever recalled the first gastrectomy ever done in the United States, which was done in San Francisco by Doctor Brigham. It was a total gastrectomy and the anastomosis was made between the œsophagus and the open end of the duodenum with a Murphy button. That shows that quite widely distant parts can be brought together under reasonable favorable conditions.

DR. EMMET RIXFORD (San Francisco, California) added to what Doctor Cheever has said, that the patient lived many years after this operation of Doctor Brigham's.

In the absence of Doctor Finney Doctor Rixford said he might suggest that possibly Doctor Balfour had added a little item in favor of the Finney pyloroplasty. He did not know what the rate of recurrence of gastric jejunal ulcers is after the Finney operation. After the symposium of last year on gastric ulcers, it would seem that the last word had been said about gastroenterostomy as a solution of the problems of duodenal

ulcers. The only criticism that he thought could be made of the finality of the decision of the Association on that occasion is that the plastic operation that is done so much now in southern Europe didn't have quite a fair hearing. It was not presented by anybody, and there was no comparison between the two.

This work of Doctor Balfour's savors of the two; it savors of the Finney idea of opening up the pylorus in the duodenum, and of resection of a large amount of the stomach, which is the thing advocated by the men in southern Europe, with the idea of lessening the amount of hydrochloric acid secreted by the stomach by thoroughly cutting the pylorus away from the rest of the stomach. The thing is still just a little *sub rosa* in regard to the relative position of this operation that is done in Europe as compared to gastroenterostomy.

DOCTOR BALFOUR rejoined that he had intended to restrict the discussion to those cases in which it has been made obvious that the jejunum will not stand, or hook up with the stomach; in other words, those few patients who, for some reason or other, develop jejunal ulcers after an anastomosis between the stomach and the jejunum. That is the puzzle. Why is it that only a few out of a hundred will develop a jejunal ulcer? A restoration of the stomach to the duodenum is something to be kept in mind.

He thought it proper now to say that he was not discussing here at all the question of primary, partial gastrectomies or lesions, particularly lesions of the duodenum. Those who have followed very closely the work of the continental surgeons who are advocating radical operations for duodenal ulcers are convinced of one or two points:

(1) As Walter has recently showed—he has just been over there and spent six weeks in very carefully studying the work going on in those clinics, and he is convinced of the truth of what they said—they are dealing with entirely different lesions; that is, they are large perforating lesions associated with marked gastritis. They talk a great deal of gastritis associated with these lesions. Whether that is due to the delay in treating these patients, a delay in surgery, or whether it is due to the type of life which is led there (frequent and hearty eating of perhaps undigestible foods), it is hard to tell. Anyway, he was convinced that those lesions were of an entirely different type, and might lead surgeons into more radical procedures.

(2) The most interesting thing he got out of the report he made was that about 80 per cent. in the clinics that have made careful investigations, have perfect results from resections; and 20 per cent. of the patients who follow along with dyspepsia are put down to gastritis.

Of course, this can be continued almost indefinitely, this discussion of a partial gastrectomy of the duodenum. At one clinic, they are all doing one thing; at another clinic, the man says that that is no good, and he advocates something else. So it is rather confusing. But he thought through it all one finds that things are not entirely all right with those who advocate a more radical procedure, and it leaves one the feeling that it is best to do a conservative operation because it at least carries a low mortality rate.

# CALCIUM CARBONATE GALL-STONES AND CALCIFICATION OF THE GALL-BLADDER FOLLOWING CYSTIC-DUCT OBSTRUCTION

By Dallas B. Phemister, M.D., Allan G. Rewbridge, M.D., and Hillyer Rudisill, Jr., M.D.

of Chicago, Ill.

From the Department of Surgery and Division of Röntgenology of the University of Chicago

Calcium carbonate may be found in the gall-bladder either as a constituent of gall-stones of the cholesterol-calcium-bile-pigment varieties, which is a very common finding, or as a separate deposit. The latter may be either in stone form or in the form of a milky suspension or paste. In treatises on gall-stones such as Aschoff and Bacmeister,[1] Lichtwitz,[2] Graham,[3] and Rallesten and McNee,[4] calcium-carbonate stones or paste are usually mentioned as a variety but no cases are cited, no stones are reproduced and the statement is generally made that the condition is very rare. The only recent cases in which chemically proven calcium-carbonate deposits in almost pure form have been found in the gall-bladder are in the reports of Volckmann,[5] Deml and Schultze,[6] Freeman,[7] Willich,[8] and Sasse.[9] In seven cases reported by these authors a whitish to gray material was found in the gall-bladder which consisted of a high percentage of pure calcium carbonate. In five cases it was in the form of a thick liquid which was designated as lime-water bile ("Kalkmilchgalle") by Volckmann. In the case of Freeman the gall-bladder and cystic duct were found to be filled with a whitish paste which cast an opaque shadow in the X-ray. In one case reported by Deml and Schultze, there was a combination of "lime-water bile" and a white, soft stone incorporating smaller brown stones. In Willich's first case there were three soft, clay-colored stones of calcium carbonate each of which incorporated small brown stones. In addition to the calcium-carbonate deposit, the gall-bladder contained ordinary gall-stones of the cholesterol or cholesterol-calcium pigment variety in every case except that of Freeman. No mention was made of obstruction of the cystic duct in any of the cases except the two reported by Volckmann in which a pigment stone was lodged in it. Despite this fact, an analysis of these cases reveals that bile was not found in the gall-bladder except in the first case reported by Willich. This would indicate that obstruction produced either by a stone in the neck of the gall-bladder or duct or by inflammation must have been present excluding the bile from the gall-bladder. Volckmann mentions that the "lime-water bile" in his cases may have been secreted by the gall-bladder wall secondary to the duct obstruction.

Calcium carbonate is responsible for the radio opaque shadows cast by gall-stones in röntgenograms, since the absorption value of cholesterol is below that of water and of calcium bilirubinate only very slightly above, while

that of calcium carbonate is fifteen times as great. A review of treatises on X-ray diagnosis of gall-stones, such as Carmen,[10] George and Leonard,[11] Schinz, Baensch, and Friedl,[12] and Eisler and Kopstein,[13] reveals numerous cases that present the röntgenologic aspects of calcium-carbonate stones or paste but as a rule the correlation of röntgenologic, pathologic and chemical findings is not sufficiently adequate for the establishment of an accurate diagnosis. In discussing the pathology of the gall-bladder in cases of cystic-duct obstruction Kaufmann[14] states that in some cases the gall-bladder may be found contracted and filled with a chalky gravel (Kalkgries).

In our studies of seven cases diagnosed as calcium-carbonate deposits in the lumen of the gall-bladder, the observation has been made that the cystic duct or neck of the gall-bladder was obstructed by a gall-stone of the ordinary cholesterol or cholesterol-pigment variety in every instance. Dr. Allen Whipple, of New York, has kindly furnished us with a report of calcium-carbonate paste in a gall-bladder, the cystic duct of which was obstructed by a carcinoma which was primary in the gall-bladder. These findings indicate that the duct obstruction was a precursor and a determining factor in the calcium-carbonate stone or paste formation. In the cases in which the duct was obstructed by a calculus, the order of development of changes appeared to be as follows: First, there was cholecystitis and the formation of gall-stones of either cholesterol or cholesterol-calcium-bile-pigment variety. One of the stones produced obstruction either in the cystic duct or in the ampulla of the gall-bladder. Following this a pathologic condition was set up whereby calcium carbonate was excreted by the wall of the gall-bladder, in one case forming a separate stone, in five cases encasing preëxisting cholesterol-pigment stones, and in one case forming a combination of a white paste and a white stone encasing preëxisting cholesterol-bile-pigment stones. The ordinary stones appear to act as a trigger for the precipitation of the calcium carbonate. In four cases the calcium carbonate produced the X-ray appearance of concentrated radio-opaque dye (iodeikon) in a gall-bladder containing either no stones or radio-translucent stones. In three cases there was deposition of calcium carbonate on the gall-bladder side of the obstructing stone, producing a shadow in röntgenograms which made it possible to diagnose the presence of calculous obstruction of the duct as well as calcium-carbonate deposition in the cavity of the gall-bladder. The condition has been met with four times among 313 cases of gall-stones in the University of Chicago clinics during the three years and eight months that they have been open, showing that the lesion is not extremely rare. Two cases are from the Presbyterian Hospital and one from the Peking Union Hospital. A preliminary report of these cases has been made (J. A. M. A.).

CASE I.—*Cholesterol stone in cystic duct with slow growth of calcium-carbonate stone in gall-bladder and calcium-carbonate deposit on stone in cystic duct revealed by a series of röntgenograms.* Woman, age forty-four, had had repeated attacks of pain in the epigastrium and, curiously, the left upper quadrant extending to the left scapular region for the past fifteen years. Following an attack a cholecystography was per-
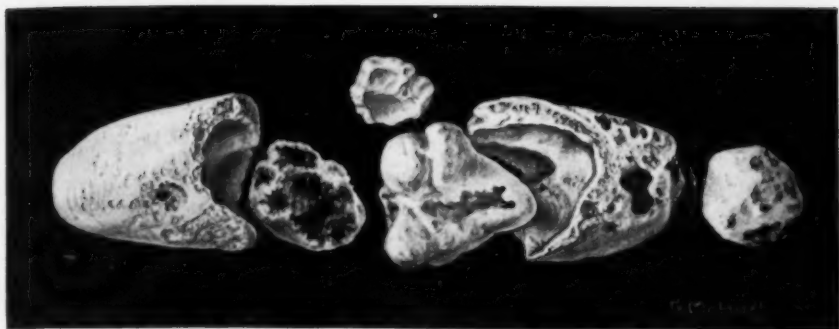
Plate I-a.—Case II. Fragments of large stone incorporating cholesterol-pigment stones. Cystic-duct stone shown at right capped with calcium carbonate on gall-bladder side.



Plate I-b.—Case III. Actual size drawing. Cholesterol-pigment stone at end.
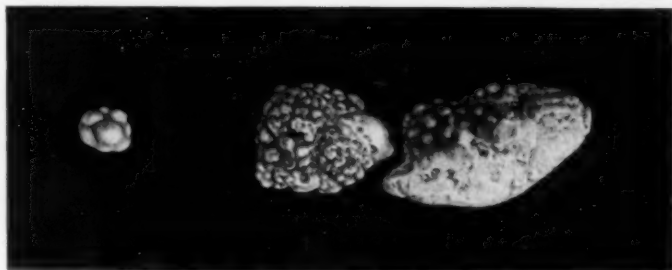


Plate I-c.—Case IV. Drawn 1 1/7 times actual size. Note mulberry stones embedded in calcium-carbonate stone at right and cystic duct stone at left.

formed March 28, 1928. The röntgenogram taken before the dye was given, showed a quarter-moon-shaped dense shadow in the gall-bladder region. There was no change in density in the gall-bladder region in the pictures taken after the dye was administered. A second röntgenogram taken seventeen days later showed a shadow of the same size which had taken on a serpentine configuration (Fig. 1). In June, 1928, an abdominal hysterectomy was performed for fibroids at which time palpation revealed
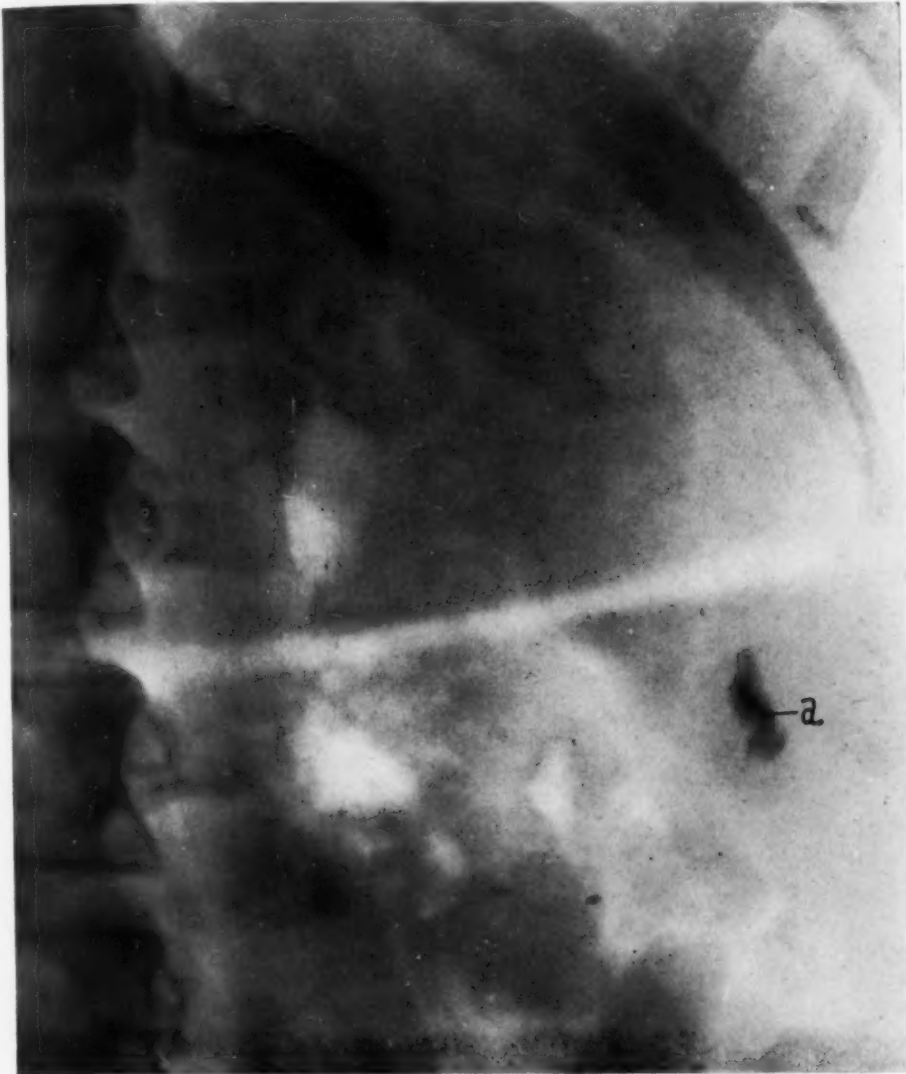


FIG. 1.—Case I. Shadow in gall-bladder region (a) April 14, 1928.

a stone in the cystic duct. Following a moderately severe attack of colic, another röntgenogram was taken May 31, 1930. It revealed marked enlargement of the dense shadow in the region of the gall-bladder which had taken on an oval form and there was a faint half-moon-shaped shadow in the region of the cystic duct (Fig. 2). The patient continued to have slight attacks of colic at irregular intervals. February 28, 1931, a röntgenogram showed slight enlargement of the shadow and a change in contour to

495

FIG. 2.—Case I. May 31, 1930. Gall-bladder stone enlarged and (a) shadow in region of cystic duct.

FIG. 3.—Case I. March 2, 1931. Cystic-duct stone (a) Gall-bladder shadow (b).

that of a half moon. Three days later the shadow had the contour of an agar slant (Fig. 3). The shadow in the region of the cystic duct had increased in density. Another röntgenogram April 28, 1931, showed a return of the shadow to approximately the configuration of May 31, 1930 (Fig. 4).

*At operation.*—April 29, 1931, the gall-bladder was found to be moderately contracted and its wall thickened. A stone was found in the gall-bladder and one in the cystic duct. Cholecystectomy was performed including the cystic duct containing the stone. A röntgenogram of the specimen (Fig. 5) shows a large dense oval shadow in
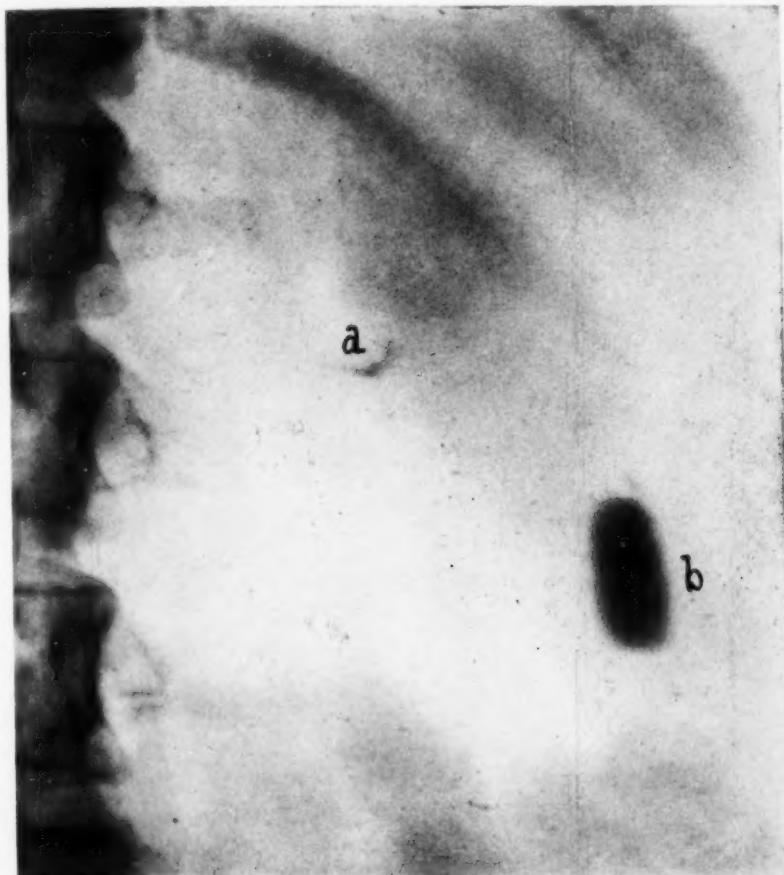


Fig. 4.—Case I. April 28, 1931. (*a*) Cystic-duct shadow; (*b*) gall-bladder shadow.

the fundus of the gall-bladder, numerous flecks throughout its remaining portion and an irregular half-moon-shaped shadow cast by the gall-bladder side of the stone in the duct. An attempt at aspiration yielded a small amount of very thick mucus. Longitudinal section of the specimen (Fig. 6) showed a cholesterol stone about 3/4 centimetre in diameter in the first portion of the duct, with a white deposit on its side projecting into the gall-bladder. There was a soft pliable white oval stone in the fundus weighing 4.580 grams. The rest of the gall-bladder was filled by a clear, very thick mucinous material which was dotted irregularly with white flakes. The wall of the gall-bladder was moderately thickened. Aërobic and anaërobic cultures of the mucin and of the wall were negative. A sample of mucin containing flakes showed: calcium 600 milligrams per 100 cubic centimetres.

32

Microscopic sections of the wall revealed moderate fibrous thickening with scattered areas of round-cell infiltration. The mucosa was intact in most of its extent but had disappeared over many of the villi which showed an increase in the number of fibroblasts and round-cell infiltration. Some of the villi showed glands markedly distended with mucus (Fig. 7).

Chemical analysis of the white stone gave calcium carbonate 85 per cent., and calcium phosphate 2.5 per cent. The rest consisted of organic matter. There was no bile pigment or cholesterol.

CASE II.—*Calcium-carbonate stones incorporating other stones and producing the X-ray picture resembling concentrated radio-opaque dye in the gall-bladder.* Female, age fifty-five, had had attacks of gall-stone colic at irregular intervals for several years. There had never been jaundice but some of the attacks had apparently been accompanied



Fig. 5



Fig. 6

FIG. 5.—Case I. Röntgenogram of specimen showing (a) cystic-duct stone; (b) gall-bladder stone and numerous calcium flakes.
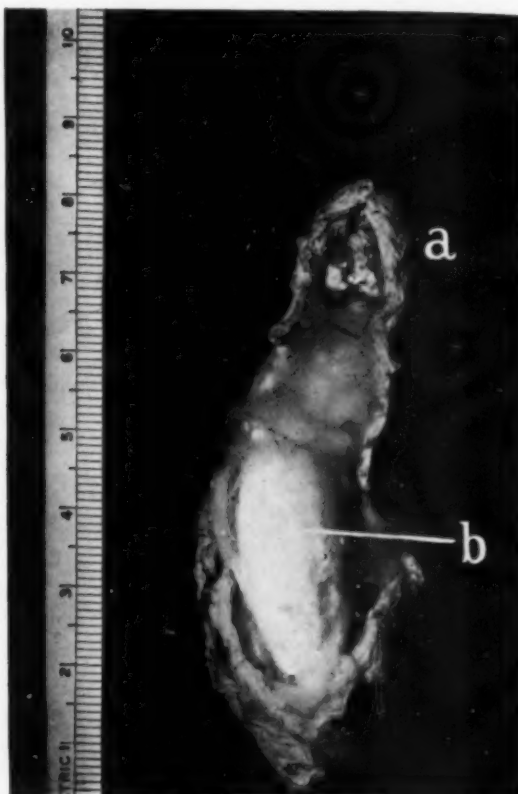
FIG. 6.—Case I. Gall-bladder opened showing (a) cystic-duct stone; (b) Gall-bladder stone and mucus in gall-bladder.

by fever. Physical examination was of no special interest aside from tenderness in the right upper quadrant. A röntgenogram (Fig. 8), taken nine months before admission, revealed an opaque shadow of the size and shape of the gall-bladder and containing two translucent areas suggesting radio-translucent stones. A new radiogram (Fig. 9) showed the opaque shadow and the radio-translucent areas within it more sharply circumscribed than before. Röntgenograms taken after administration of iodeikon showed no change in the shadow.

*At operation.*—March 15, 1927, a thickened gall-bladder was found contracted on stones with a stone obstructing the orifice of the cystic duct. Cholecystectomy was performed. On longitudinal section of the gall-bladder, its wall was found to be slightly thickened. There was a small amount of mucinous turbid fluid in the gall-bladder that was not bile stained. The rest of the space was occupied by calculi. There was a soft oval-shaped white calculus 6 centimetres long occupying the central portion. A small white conglomerate calculus occupied the tip of the fundus and a brown calculus was wedged in the orifice of the cystic duct with a white cap on its gall-bladder side. These are shown in a photograph in Fig. 10 and a drawing of the stones is shown in Plate I–a. Three very small brown pigment stones lay free alongside the large stone. The large soft white stone was found to contain several mottled-grayish-brown, bile-pigment-cholesterol stones on the inside.
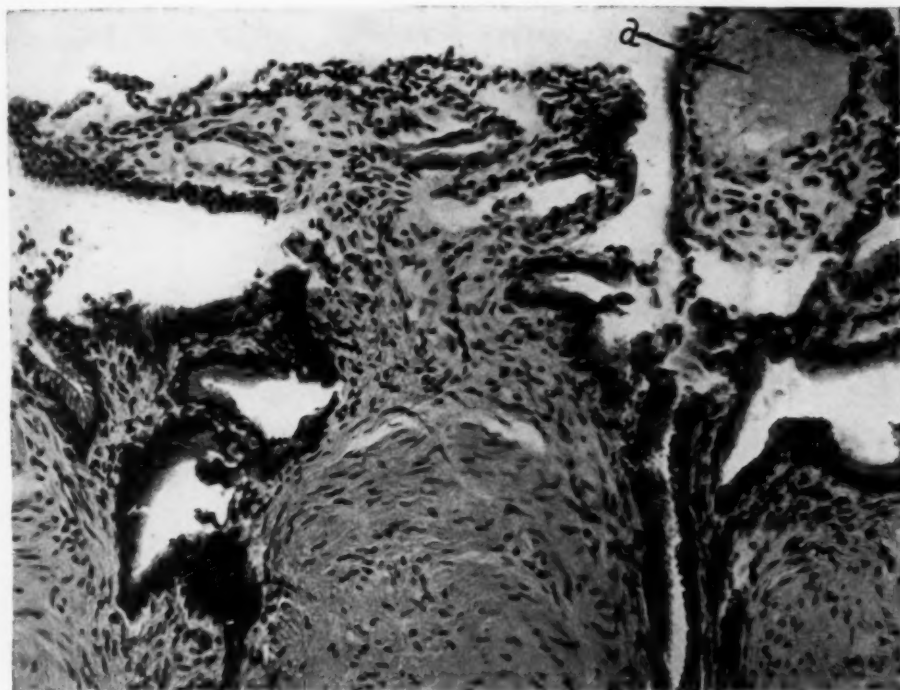


Fig. 7.—Case I. Gall-bladder wall showing partial loss of epithelium and (*a*) villus filled with mucus.

Cultures of the fluid in the gall-bladder were negative. Microscopic examination of the wall showed moderate thickening with loss of mucous membrane and villi over nine-tenths of the surface lining. At irregular intervals there were small stretches of mucosa and of glands imbedded in the deeper tissue. There was moderate fibrosis and round-cell infiltration of the wall. Chemical analysis of a portion of the white material, comprising the largest stone, gave the following results: calcium carbonate, 75 per cent.; calcium phosphate, 2 per cent.; cholesterol, a trace; bile pigment, none; organic matter, the remaining portion.

CASE III.—*Large calcium-carbonate stone with stone in cystic duct but with some bile entering the gall-bladder.* Male, age sixty-five, for thirty-five years had had bilious attacks and for seven years attacks of pain in the epigastrium which were severe and radiating and were brought on by eating a heavy meal. In addition, the patient had had mild attacks of angina pectoris for some time. Röntgenogram showed a large oval opaque shadow in the region of the gall-bladder. *Operation.*—December 30, 1926, by

Dr. E. M. Miller, at the Presbyterian Hospital. The gall-bladder contained a large stone and there was a stone in the cystic duct which was milked out with great difficulty. Cholecystectomy. The gall-bladder was contracted and its wall thickened. On section it was found to contain a few cubic centimetres of a bile-stained mucous fluid and a large clay-colored oval stone measuring 6.5 by 2.5 centimetres. The stone was soft and sticky and there was a greenish bile stain on its surface. Section of the stone also showed that its interior was slightly bile stained. At one end a dark brown concretion presented on its surface (Plate I-b). In a röntgenogram this area is radio



FIG. 8.—Case II. Röntgenogram May 6, 1926, showing (a) radio-translucent shadows in opaque gall-bladder shadow.

translucent while the rest of the stone is radio opaque (Fig. 11). The lining of the gall-bladder was hyperæmic and covered with mucus. Microscopic section of the gall-bladder revealed loss of the greater portion of the mucous membrane leaving connective tissue bordering on the lumen (Fig. 12). There was slight round-cell infiltration and fibrosis of the muscular and serous layers. The stone weighed 18.258 grams. Chemical analysis of the gray stone showed it to contain 80 per cent. of calcium carbonate and 0.46 per cent. of calcium phosphate. The rest of it consisted of organic matter. Bilirubin was present and cholesterol was absent.

Although there was a stone in the cystic duct it evidently had not produced complete obstruction continuously since some bile was found in the gall-bladder and the interior of the stone was bile stained. As this was the largest stone that was found it would appear that almost pure calcium carbonate may be thrown out in the gall-bladder

while bile is still entering it at least periodically and complete and permanent obstruction of the duct does not appear to be a necessity for calcium-carbonate stone formation.

CASE IV.—Male, age thirty-two, had had attacks of pain in the epigastrium and back at irregular intervals for one year. The attacks were brought on by heavy eating and were most frequent of evenings. They, as a rule, passed off within an hour but a recent attack had produced vomiting and lasted for twenty-four hours. No history of jaundice or of febrile attacks. Physical examination was negative aside from tenderness in the right upper quadrant of the abdomen. The gall-bladder was not palpable.

A röntgenogram revealed two shadows in the region of the gall-bladder. The lower one was oval and opaque except for three small translucent areas in its interior. Above this was a smaller oval shadow with an opaque periphery. Lateral to the right transverse process of the second lumbar vertebra was a small opaque oval shadow measuring 1 centimetre in its long axis (Fig. 13). There was no change in the gall-bladder shadow after intravenous administration of iodeikon. A diagnosis was made of calculus obstruction of the cystic duct with calcium-carbonate deposition about radio-translucent gall-stones in the gall-bladder.

*Operation.*—March 15, 1930. The gall-bladder was found thickened and decreased in size. It contained stones and fluid and there was a stone in the cystic duct, near the common duct. Cholecystectomy and removal of cystic-duct stone. Convalescence was uneventful. A röntgenogram taken two weeks later showed an absence of all stone shadows. Eight cubic centimetres of fluid was aspirated from the gall-bladder for chemical analysis. It was slightly bile stained. Chemical analysis revealed: pH—7.195; $CO_2$—5.55 vols. per cent., calcium 163 mg/100 cubic centimetres.



FIG. 9.— Case II. February 26, 1927. Röntgenogram before dye was given.

The gall-bladder was sausage shaped and somewhat smaller than normal. On section, the wall was moderately thickened and the serosa smooth and shiny. It contained two large concretions. The distal one was grayish in color and soft. Its surface was smooth and in places bile stained. Two small brown pigment stones presented along its surface on one side. The proximal stone was smaller and brown in color except for a gray coating which was thin and irregularly distributed except on the end which came in contact with the distal stone where it was heavily deposited. The stone in the cystic duct was mulberry shaped and consisted of brown pigment with a white

coating on its surface (Plate I–c). Cultures of the gall-bladder wall yielded an anhæmolytic streptococcus. Microscopic sections of the gall-bladder showed the mucosa to be intact but there was mucous accumulation in some of the villi with loss of epithelial covering in places. There was fibrosis of the entire gall-bladder wall with some infiltration of polymorphonuclear leucocytes and lymphocytes. A röntgenogram of the stones



FIG. 10.—Case II. Gall-bladder opened. (*a*) Stone in cystic duct. (*b*) Cholesterol-pigment stone showing on broken surface of the calcium-carbonate stone.

in the gall-bladder (Fig. 14) brings out well the calcium-carbonate coating of the proximal bile-pigment-cholesterol stone and the small, radio-translucent calculous inclusions in the distal stone. Chemical analysis of the grayish-white material comprising the distal stone revealed calcium carbonate 74 per cent., calcium phosphate 3.1 per cent., cholesterol and bile pigment present in small amount. The rest of the stone consisted
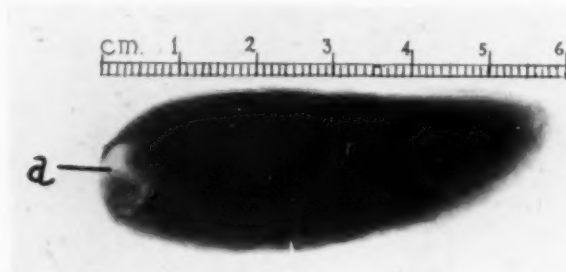


FIG. 11.—Case III. Röntgenogram of stone showing (*a*) cholesterol-pigment stone incorporated.

of organic matter. The presence of a small amount of bile in the fluid and of bile pigment in the calcium-carbonate stone showed that some bile was entering the gall-bladder at least at times despite the stone in the cystic duct. However, the amount of fluid passing by the stone must have been enormously reduced as shown by its considerable size and by the failure of concentration of iodeikon in the gall-bladder.

CASE V.—*Shows a combination of chalky fluid in the gall-bladder and duct with a pasty opaque stone incorporating several bile-pigment stones.* Female, age twenty-six, treated in Pekin Union Medical College. She gave a history of attack of right upper quadrant pain radiating to right shoulder occurring at intervals over a period of two years. They often started with nausea and vomiting and were usually of short duration. There was no history of jaundice or fever. Physical examination was essentially negative aside from tenderness in the gall-bladder region. A röntgenogram (Fig. 15) revealed an opaque shadow roughly outlining the lower part of the gall-bladder. There was no

change in the shadow after iodeikon administration. At operation the gall-bladder was distended and non-compressible and a stone was found in the cystic duct near its junction with the common duct. The gall-bladder and most of the cystic duct were removed. The cystic duct, after removal of the stone, was tied near the common duct. *Pathologic report.*—The gall-bladder measured 8 centimetres in length by 2½ centimetres in its greatest diameter. A röntgenogram (Fig. 16) of the specimen showed an irregularly oval opaque mass in the fundus, a few scattered flecks through the gall-bladder and cystic duct and an opaque shadow in the region of a diverticulum near the end of the cystic duct. On opening the gall-bladder it was found to contain several cubic centimetres of a milky fund with an oval pasty mass in the fundus which incorporated six small white gallstones.

Cultures of the fluid in the gall-bladder were sterile. Microscopic examination
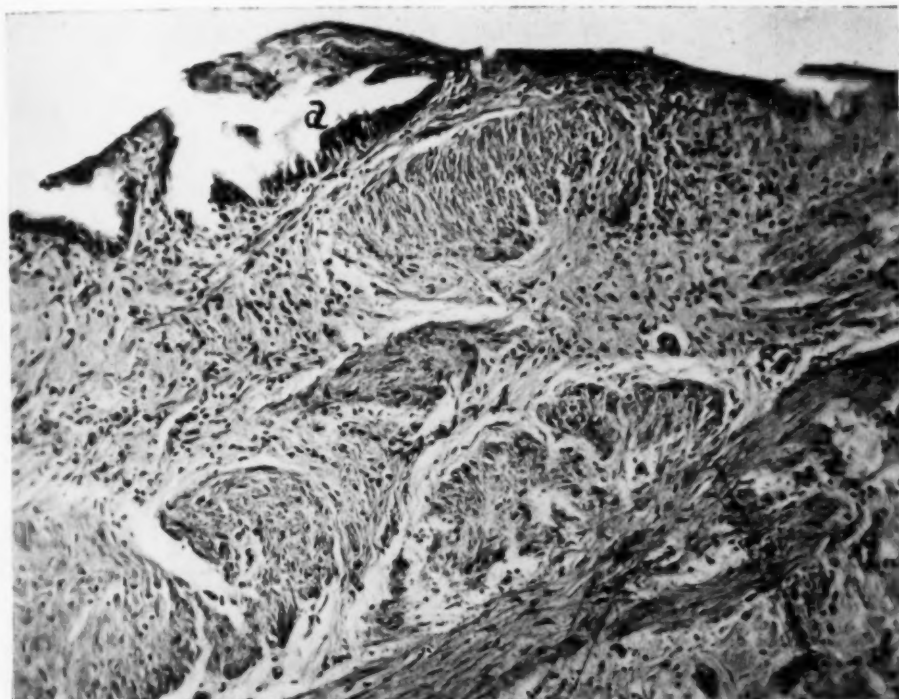


Fig. 12.—Case III. Gall-bladder wall showing loss of mucosa except at (a).

showed the mucosa of the gall-bladder to be intact. The wall was thickened and infiltrated with a moderate number of lymphocytes. Chemical analysis of the pasty mass in the fundus of the gall-bladder showed it to contain a high percentage of calcium and of the stones showed them to be almost pure calcium carbonate. Convalescence was uneventful.

CASE VI.—Woman, age thirty-seven, entered the University of Chicago clinics, May 28, 1929. She gave a history of attacks of pain in the right upper quadrant of the abdomen with radiation to the back at irregular intervals during the past six years. The pain would sometimes last for a day or two and usually began after meals and attacks of bloating and belching were common. There had been no jaundice, fever, or clay-colored stools. Physical examination revealed a well-nourished and well-developed woman. Regional examination was essentially negative. There was no mass

or tenderness in the gall-bladder region. A röntgenogram of the gall-bladder region (Fig. 17) revealed a finger-shaped opaque shadow in the region of the gall-bladder which was rounded at its lower end and irregular at its upper end. Above this and near the tip of the right transverse process of the first lumbar vertebra was an irregular ring-shaped opaque shadow in the region of the cystic duct. Röntgenograms taken after intravenous iodeikon administration at intervals for thirty-six hours showed changes in the contour of the gall-bladder shadow but no increase in its size or density and no change in the shadow in the region of the cystic duct. The diagnosis was made of a gall-stone obstructing the cystic duct with deposition of calcium carbonate on its surface



Fig. 13.—Case III. Shadows in region of gall-bladder incorporating radio-translucent areas and (a) shadow in region of cystic duct.

and a calcium-carbonate deposit in the gall-bladder that was soft in consistency and changeable in form. The patient refused operation.

CASE VII.—Female, age thirty-one, entered the University of Chicago clinics, May 15, 1930. Past and family histories were irrelevant. Five months previously she had an attack of upper abdominal pain which radiated to the right shoulder lasting for about two hours. Since then there have been three similar attacks, the last one occurring about three weeks ago. She sometimes had distress after meals which was relieved by belching. There had been no jaundice and no fever. Physical examination revealed an obese young woman with essentially negative regional findings aside from tender-

ness in the gall-bladder region. A röntgenogram (Fig. 18) revealed a long narrow opaque shadow in the region of the gall-bladder and cystic duct containing several rounded translucent areas resembling radio-translucent stones in heavily concentrated iodeikon. There was a ring-shaped shadow near the tip of the right transverse process of the first lumbar vertebra which was denser on the gall-bladder side. There was no change in the X-ray shadows after iodeikon administration. A diagnosis was made of radio-translucent stones in the gall-bladder and one stone in the cystic duct with calcium carbonate deposited on its surface and a calcium carbonate deposit filling the gall-bladder and a portion of the cystic duct. The patient refused operation.

CASE VIII.—(*Summary of Dr. Whipple's Case.*) Woman had had short attacks of epigastric pain with inceasing severity over a period of four months, and loss of fifteen pounds in weight. Gall-bladder barely palpable but tender. X-ray revealed heavy calcareous shadow outlining the gall-bladder. There was a continuous low-grade fever.

*At operation.*—There were carcinoma nodules in the liver and the gall-bladder, when opened, was found to be full of a white amorphous paste which was curetted out. (No mention of ordinary stone.) Chemical analysis showed it to consist of pure calcium carbonate. The gall-bladder was drained but no bile subsequently escaped. The patient continued to go downhill and died three months later.

Autopsy revealed primary carcinoma in the chronically diseased gall-bladder with metastases in the liver and obstruction of the cystic duct. Imbedded in the superficial lining of the gall-bladder were small concretions calcified but presenting a radiating appearance in their cortical portions.



FIG. 14.—Case IV. Röntgenogram of gall-bladder stones.

The pathogenesis in this case appeared to be cholecystitis and cholelithiasis, carcinoma of the gall-bladder, carcinomatous obstruction of the cystic duct and calcium-carbonate excretion and precipitation into the gall-bladder lumen.

*Discussion.*—In summarizing these cases all gave a history of relatively mild attacks of colic recurring over a period of five months to fifteen years. No patient had been jaundiced nor had had a severe febrile attack and in no instance was the gall-bladder palpable. Cholecystograms were negative for dye shadows in six cases and were not made in one. Chemical analyses of the white stones in four cases showed them to be composed of 74–85 per cent. of calcium carbonate, 0.5–3.1 per cent. of calcium phosphate and the rest organic matter. The stones in Case 5 were almost pure calcium carbonate. Bile pigment was present in two and traces of cholesterol in one of the five stones that were analysed. Some bile was present in two of the gall-bladders removed at operation. From these findings it may be concluded that calcium carbonate in almost pure form is precipitated in the gall-bladder only when there is obstruction of the cystic duct which either greatly reduces the amount of bile entering or completely excludes it. After the obstruction is established there is a persistent chronic cholecystitis with thickening of the gall-bladder wall and changes in the mucous membrane which may vary from

very slight to almost complete loss of mucous lining. There is exudation into the gall-bladder lumen which contains a variable quantity of mucus. In some cases it is extensive and very thick. The fact that in no case was there marked enlargement with hydrops of the gall-bladder suggests that when the intravesical tension passes a certain point the exudate may escape past the obstructing stone into the ducts beyond. The absence of bile and the relatively high degree of obstruction in three of the five cases coming to operation makes it appear that the calcium carbonate was excreted by the wall of the gall-bladder



FIG. 15.—Case V. Shadow has configuration of lower part of gall-bladder.

and that it was not derived from the bile. The presence in three cases of calcium-carbonate deposit on the cystic duct stone most marked or only on its gall-bladder side is further proof of the fact that it came from the exudate in the gall-bladder rather than from the bile. No adequate explanation can be offered for the selective excretion of calcium carbonate with only traces of calcium phosphate present. It may be as Naunyn[15] claimed, that calcium carbonate is poured out with mucus from the wall of the gall-bladder. Thus

conditions may be favorable only when the inflammation and obstruction are of certain degrees of severity and chronicity. Certain it is that in the majority of cases of impacted stone in the cystic duct and especially when large hydrops is present there is no throwing out of calcium carbonate in this form in the lumen of the gall-bladder. Chemical analysis of fluid from two cases of hydrops of that type showed calcium 10.1 milligrams and 7.2 milligrams per 100 cubic centimetres and pH 6.59 and 7.5. It is known that the only other calculi equally rich in calcium carbonate are found in the salivary (Besanez)[16] and pancreatic (Rosenthal)[17] ducts where mucus is also present. The presence of bile in the gall-bladder in two cases indicates that exclusion of bile continuously is not essential for the formation of calcium-carbonate stones, although the possibility exists that there may have been a change in the location of the obstructing stone letting in bile after the calcium carbonate had been deposited. Hastings and Zachariason, of the University of Chicago, demonstrated by X-ray spectograms that the calcium carbonate present in three of these cases was in the crystal form of aragonite. Wilkie[18] found experimentally in rabbits that cholecystitis plus cystic-duct ligation produced stones rich in calcium while cholecystitis without duct ligation produced cholesterol stones. We have attempted to produce calcium-carbonate stones in both dogs and rabbits by the injection of streptococci into the gall-bladder wall with and without cystic-duct ligation, but so far have met with no success.



FIG. 16.—Case V. Röntgenogram of gall-bladder and cystic duct. Opaque mass in fundus and in diverticulum of duct.

The observation of a relationship between cystic-duct obstruction and calcium-carbonate deposition in the gall-bladder lumen raises the question as to whether or not the layers of calcium carbonate that are so often found in cholesterol-pigment stones or deposited on cholesterol stones may not be laid down during periods of temporary obstruction of varying grades produced by a stone in the neck of the inflamed gall-bladder or in passage through the duct; also if the calcium may not come from the wall of the gall-bladder instead of from the bile as appears to be the case from the work of Rous[19] when it constitutes the nucleus of stones. Lichtwitz and Bock[20] claim that when there is inflammation and stasis in the gall-bladder the calcium content of the bile is increased. Andrews and Hrdina[21] have found experimentally

507

in dogs that ligation of the cystic duct with or without infection caused a lowering of calcium in the bile of the gall-bladder.

*Calcification of the Gall-Bladder.*—Calcification of the gall-bladder wall with or without associated ossification is an occasional finding particularly at autopsy. It represents an end stage of disease which greatly alters the morphology of the gall-bladder and completely destroys its function. Kaufmann states that it results from a chronic fibrous cholecystitis with diffuse fibrosis and loss of the mucous lining of the gall-bladder. Following this
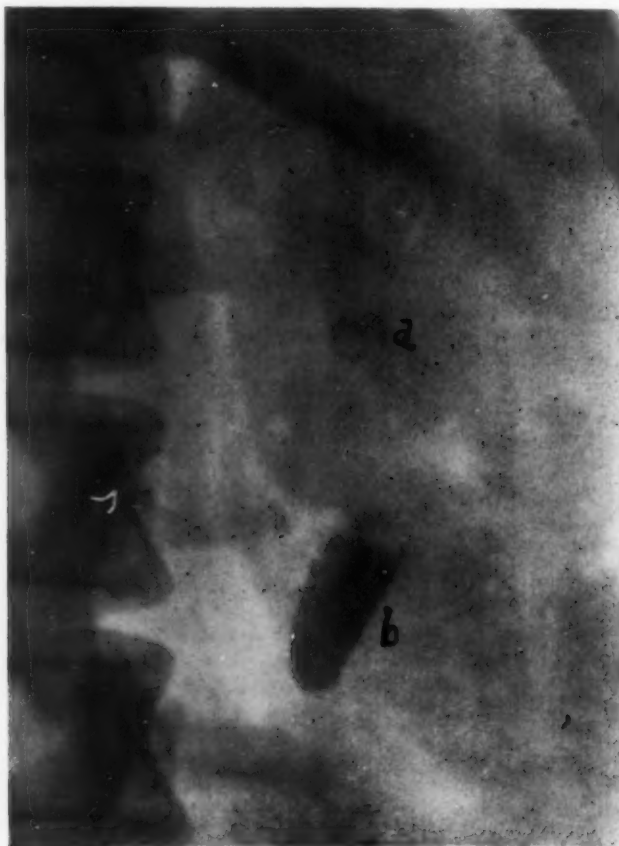


Fig. 17.—Case VI. Showing shadows in (*a*) cystic duct and (*b*) gall-bladder.

there is deposition of lime salts in the gall-bladder wall. Sometimes the calcified areas may be partly replaced by bone. Osler[22] stated that calcification may be a termination of suppurative cholecystitis. Robb,[23] on the other hand, believes that calcification may develop in the absence of infection. He thinks that the constant trauma of stones filling the gall-bladder results in degeneration and fibrous replacement of the tissues of the wall. Fibrosis leads to contracture followed by calcification. In a study of four specimens of calcified gall-bladder derived from autopsies and one operative specimen,

508

it was noted that bile was absent from the gall-bladder in all cases. In four cases there was a stone in the cystic duct cemented to its wall and completely obstructing the lumen. In one case there was a large stone filling the gall-bladder and the cystic duct was completely closed at the gall-bladder orifice by an overgrowth of fibrous tissue. These cases emphasize the importance of cystic-duct obstruction in the development of calcification of the gall-bladder. Figure 19 shows a röntgenogram of a museum specimen of a gall-bladder 9 centimetres in length. It contained cholesterol-bile-pigment stones,
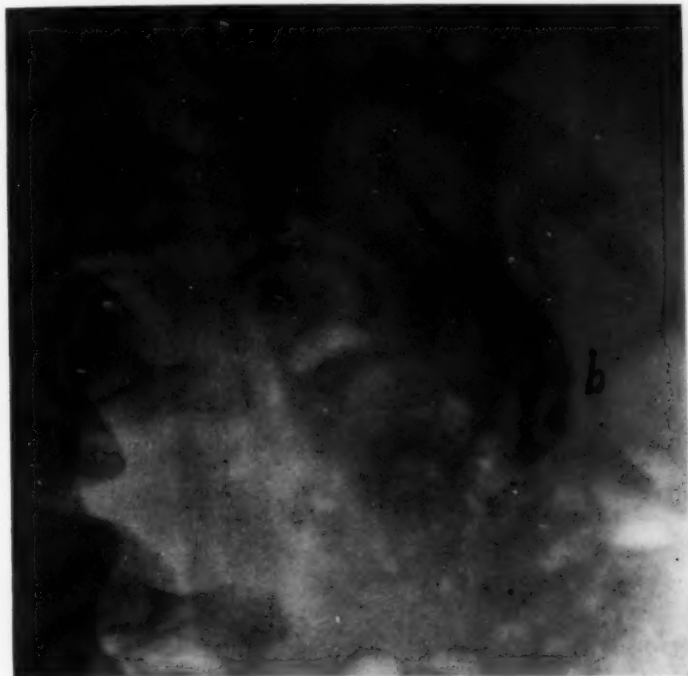


FIG. 18.—Case VII. Showing shadows in (*a*) cystic duct and (*b*) gall-bladder with radio-translucent stones in latter.

one of which was impacted in the neck of the gall-bladder. The fundus of the gall-bladder was stony hard as was also the portion of the cystic duct surrounding the stone. The surfaces of the cystic duct and stone were fused by a calcareous deposit. Microscopic sections of the wall of the gall-bladder showed a complete absence of mucosa and decalcified sections of a portion of the fundus showed the entire thickness of the wall to be heavily calcified. Chemical analysis of a small portion showed the inorganic content to consist almost entirely of calcium phosphate.

Figure 20 is a photograph of a gall-bladder containing two large cholesterol-pigment stones with a similar stone lodged in the cystic duct and fused with it by a heavy calcareous deposit. There were scattered hard plaques in the wall of the gall-bladder. A röntgenogram (Fig. 21) shows scattered shadows cast by the calcareous deposits in the gall-bladder wall and

the heavy deposit in the cystic duct. Microscopic section (Fig. 22) showed complete fibrosis of the gall-bladder wall with loss of mucous membrane and areas of calcification in the deeper portions of the fibrous tissue.

Figure 23 shows a röntgenogram of a small hard contracted gall-bladder, 4½ centimetres long, removed recently at autopsy from an eighty-two-year old woman dying of carcinoma of the lung. She gave no history of gall-bladder disturbance. On trying to open the gall-bladder a large pure choles-terol stone was found impacted in the neck and first portion of the cystic



FIG. 19.—Röntgenogram of gall-blad-der showing calcification of fundus and of cystic duct (a) at point of impaction of a cholesterol-pigment stone.

FIG. 20.—Calcified gall-bladder with window excised showing two cholesterol-pigment stones within and (a) cystic-duct stone with calcareous deposit.

duct and fused with the wall by a calcareous deposit. The fundus of the gall-bladder was calcified and its small cavity was filled by a grumous mate-rial. Microscopic sections of the fundus showed fibrous tissue replacement of the entire thickness of the wall with a mixture of calcification and ossifica-tion in places. The mucosa was completely destroyed.

In another museum specimen the oval gall-bladder was hard and measured 6 centimetres in length. It was completely filled by a stone which was made up very largely of cholesterol and contained two layers of calcium in its deeper portion as shown by shadows cast in röntgenograms. The wall of the gall-bladder was fibrosed and irregularly calcified throughout. The opening of the cystic duct was completely grown over by connective tissue.

In the following case there was loss of most of the mucosa with calcification of fibrous tissue growing inward from the fibrosed wall of the gall-bladder encasing and cementing to it a mass of stones within.

Female, colored, age seventy, had attacks of upper abdominal pain eight years ago which were diagnosed as due to gall-stones. Abdominal symptoms then disappeared until five months ago when she again had pain in the right upper quadrant which was occasionally sharp and stabbing but which has been more or less continuous. No nausea or vomiting with recent attacks and there was no history of jaundice or chills and fever. Past history and physical examination revealed no findings of special interest, aside from a small, deeply lying slightly tender mass in the gall-bladder region. Skin and sclera not jaundiced.

*At operation.*—A small stony hard gall-bladder was found which was free from adhesions. Cholecystectomy was p e r f o r m e d which was followed by an uneventful convalescence.

Examination of the excised specimen revealed a small stony hard, pear-shaped gall-bladder and first portion of the cystic duct 6 centimetres in length. The outer layers were moderately thickened. They were incised and peeled off of the hard internal layer of the gall-bladder and duct leaving a thin whitish shell about a mass of stones within the gall-bladder and one stone in the duct. A röntgenogram of the specimen (Fig. 24) showed the outlines of medium-sized stones filling the gall-bladder. In addition there is a shell-like, dense shadow surrounding the stones in the gall-bladder and the one in the cystic duct. On opening the specimen, it was found that there was a whitish deposit cementing the inner surface of the shell to the external surface of the stones with which it came in contact. Extending inward between some of the stones there was fibrous tissue containing a whitish deposit which, in places, was crumbly



FIG. 21.—Röntgenogram of specimen in Fig. 19, showing calcified plaques in gall-bladder wall and (*a*) calcified fused surface of cystic duct and stone.

and amorphous (Fig. 25). The stones reaching the periphery were yellowish brown in color with irregular areas of whitish deposits on their internal surfaces. Three or four stones centrally situated had extremely little or no whitish layer on their surfaces. The interior of the stones was dark brown centrally with a thick yellowish brown radiating peripheral layer on top of which the thin calcareous deposit was seen in places. The stone in the cystic duct was cemented to the wall by the calcareous deposit. On section it had the composition of the stones in the gall-bladder which were composed of cholesterol and bile pigment with calcium carbonate incorporated about the surface.

Microscopic examination of sections of the external soft layer showed that it consisted of markedly fibrosed muscular and serous layers with absence of mucosa except in one section where an irregular layer of flattened epithelium and glands was present. A section of the decalcified wall and one of a septum extending between two stones showed fibrous tissue with areas of degeneration and more or less heavy calcification.

Chemical analysis of some of the whitish material removed from the inside of the wall and between the stones showed it to contain 35.5 per cent. of inorganic matter of which 12½ per cent. was calcium carbonate and 87½ per cent. calcium phosphate. Hence this process was not analogous to calcium-carbonate calculus formation but was the same as the calcification which is ordinarily seen occurring in necrotic tissues anywhere in the body in which calcium carbonate and calcium phosphate are deposited in about the



FIG. 22.—Microscopic section of gall-bladder in Fig. 19, showing fibrous wall with calcified deeper portion.

same relative proportions as in bone. It appears that after cystic-duct obstruction there was degeneration, fibrosis and contracture of the gall-bladder with loss of most of the mucosa. Fibrous tissue grew over the mass of stones and in between them in places and underwent degeneration and calcification where it came in contact with them. In one region there were remnants of mucosa between this encasing layer and the outer muscular coat. It would appear as if the cholesterol-bile-pigment-calcium

512

stones, coming in contact with the wall, acted as a stimulus for calcification of the surrounding and encasing fibrous tissue, just as did the cystic-duct stone in all four specimens.

*Discussion.*—It has been generally noted that gall-stones are nearly always present when calcification of the gall-bladder occurs and obstruction of the cystic duct has been reported in a number of cases, but no particular attention seems to have been paid to the relationship between the obstruction and the calcification. Robb reported three museum specimens in all of which the cystic duct was obstructed and in two of which the wall was obviously cemented to the stone by a calcareous deposit. The operative case which he presented resembled closely the last case of this series except that the cystic-duct orifice was closed by calcified fibrous tissue instead of by an impacted gall-stone. The gall-stones were surrounded and cemented together by a white calcareous deposit and the fibrosed muscular layer was calcified. Chemical analysis of the deposit yielded for the inorganic content calcium phosphate $87\frac{1}{2}\%$, calcium carbonate $12\frac{1}{2}\%$, showing that this was tissue calcification and not stone formation. In Fowler's[24] case there was no mention of duct obstruction but there was a constriction in the gall-bladder near the ampulla and the calcified wall and calcareous contents were distal to it. Talbot[25] gives a Roentgen-ray report of a case in which there was a clean-cut shadow of calcified wall of gall-bladder and of cystic duct about a stone similar to the cases shown in Figs. 22 and 24.



Fig. 23.—Calcification and ossification of (a) wall of contracted gall-bladder and (b) wall of cystic-duct orifice on impacted cholesterol stone.

Robb calls attention to the fact that calcification of the gall-bladder occurs in patients who have had relatively few symptoms of gall-stones and who have not had symptoms of severe cholecystitis. This holds true for the two cases in this series whose clinical histories were known. This fact would favor the view that the calcification develops secondary to duct obstruction, necrosis and fibrosis, with little or no associated infection, rather than as a result of necrosis produced by severe infection.

*Summary.*—Obstruction of the cystic duct or neck of the gall-bladder by one of the common gall-stones or by a carcinoma may be followed by the precipitation within the gall-bladder of large amounts of calcium carbonate in the form of a soft, white stone, a paste or a milky suspension (lime-water bile). Obstruction, although it may be incomplete or intermittent appears to be necessary for the occurrence of the process. The calcium carbonate is thrown out in the presence of a mild chronic cholecystitis rather than a severe acute cholecystitis and it appears to come from the wall of the gall-bladder. There may also be deposition of calcium carbonate on the stone in the cystic

33                     513

duct and particularly on its gall-bladder side making it possible to diagnose both the calcium carbonate deposit in the gall-bladder and the duct obstruction by means of röntgenograms.

Obstruction of the cystic duct by one of the ordinary gall-stones may in other cases be followed by degeneration, fibrosis and calcification of the wall of the gall-bladder. In such cases there is also calcification of the cystic duct about the stone with fusion of the surfaces of stone and duct. If the gall-bladder is contracted on a mass of stones there may be calcification with cementing of the stones to the wall of the gall-bladder and to a less extent to each other. When the gall-bladder is found calcified in the absence of a stone in the cystic duct, the duct is found obliterated by fibrous tissue at its cystic end.

It should be remembered that while these two pathologic processes are
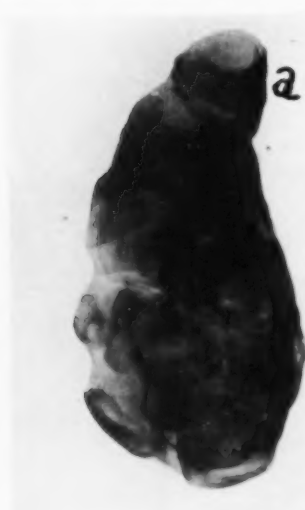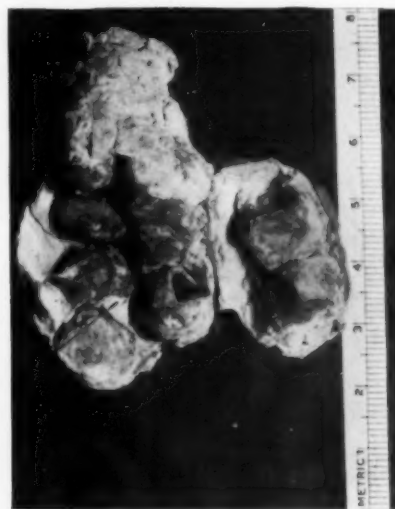


Fig. 24.                    Fig. 25.

FIG. 24.—Calcification of gall-bladder and cystic duct (a) about stones within.
FIG. 25.—Photograph of specimen in Fig. 24. Calcified wall opened and showing stones cemented to wall, and, at (a), to each other by whitish deposit.

closely related they are in reality separate biochemical changes. The calcium-carbonate deposition in the lumen belongs in the realm of stone formation while the calcium-phosphate-calcium-carbonate deposition in the gall-bladder wall belongs in the realm of tissue calcification.

DISCUSSION.—DR. LEONARD FREEMAN (Denver) said that in an instance where he had the opportunity to observe such a case as mentioned by Doctor Phemister in his paper, the deposit was entirely a soft, putty-like paste. There were no stones in connection with it at all, not even any grit of any size. There was very little evidence of inflammation of the gall-bladder. There was no obstruction at all of the cystic duct, so the explanation that the calcium deposited in the gall-bladder is due to obstruction of the duct does not seem to apply to all cases. In addition, it would not seem that the inflammation accounted for all instances, as has been suggested by some writers.

This deposit of calcium in the gall-bladder, especially in the way it was found in

my particular case, might lead to several errors, at least in taking X-ray pictures. For instance, if one has given a barium meal for the purpose of examining the gastrointestinal tract and then finds a picture of the gall-bladder looking exactly as though it were filled with barium, one might come to the conclusion that in some way or other the barium had succeeded in entering the gall-bladder. That does not sound probable, but in looking up the question he found it a perfect possibility; that the barium sometimes enters the common duct, sometimes even fills all of the hepatic ducts in the liver, and may, in some instances, even get into the gall-bladder itself.

In the picture that he got of this particular gall-bladder before operation, he was absolutely convinced that the barium had entered the gall-bladder. He looked up the subject to find out if that was a possibility or not. Upon inquiring of some of the X-ray men, he found that it was.

The same thing occurred in a report by Ysaye, not long ago, in which he came to the same conclusion, that the barium meal, or some other contrast medium which he had given, had entered the gall-bladder. He was only convinced after a chemical analysis that he had to deal with calcium carbonate. The speaker was only convinced in the same way, and with a good deal of reluctance because he had committed himself on the subject very decidedly.

Then, again, in giving the dye in completing X-ray pictures of the gall-bladder, one might suppose that the gall-bladder had filled promptly and satisfactorily with the dye, and yet that would not be the case at all because it would be the calcium carbonate. Of course, in subsequent pictures taken, one would find out that the gall-bladder did not empty itself and then one would probably be suspicious that he might have to deal with the calcium carbonate.

DR. FRANK S. MATHEWS (New York City) said that in 6700 gall-bladders, he had only recognized one specimen of this sort. That case was seen before the day of cholecystography. They had a beautiful picture of the shadow of the gall-bladder. Upon operation, the gall-bladder felt rigid; it contained a material that was like a tooth-paste, with very few stones imbedded in it; and it was perfectly white. There obviously had been no bile in the gall-bladder for a long time. Whether or not there was a stone actually obstructing the cystic duct, he did not remember. Because the appearance of the material was so unlike the ordinary contents when there is a stone in the gall-bladder was the reason for having the material examined.

DR. D. B. PHEMISTER (Chicago, Illinois) said, in reply to Doctor Freeman, he believed that obstruction is necessary for the formation of the calcium-carbonate stones. The obstruction may be due to stone, carcinoma, or perhaps even inflammation. It is certain that a stone is the common cause. It may be either in the neck of the gallbladder or cystic duct and from a review of the few cases that have been reported he thought that it was an easy matter to overlook the obstruction.

## REFERENCES

[1] Aschoff, and Bacmeister: Die Cholelithiasis. Jena, 1909.

[2] Lichtwitz: Über die Bildung der Harn-und-Gallensteine. Berlin, 1914.

[3] Graham, Cole, Copher, Moore: Diseases of the Gall-bladder and Bile-ducts. St. Louis, 1929.

[4] Ralleston, and McNee: Diseases of the Liver, Gall-bladder and Bile-ducts. Macmillan, 1929.

[5] Volckmann: Über Kalkmilchgalle. M.m. Woch., vol. lxxiii, p. 2014, 1926.

[6] Deml, and Schultze: Zur Frage der Kalkmilchgalle. M.m. Woch., vol. lxxiv, p. 363.

[7] Freeman: Gall-bladder and Cystic Duct Distended with Calcium-carbonate Paste; Cholecystectomy. Colorado Medicine, July, 1927.

[8] Willich: Über Frühformen von Gallensteinen. Mitt. aus. Gr. Med. u. Chir., vol. xxxv, p. 325, 1922.

[9] Sasse: Über Kalkmilchgalle. D. Med. Woch., vol. lvi, p. 662, 1930.

[10] Carman: The Röntgen Diagnosis of Diseases of the Alimentary Canal. Second edition, Philadelphia, 1920.

[11] George, and Leonard: Pathologic Gall-bladder Röntgenologically Considered. Hoeber, New York, 1922.

[12] Schinz, Baensch, Friedl: Lehrbuch der Röntgendiagnostik. Leipzig, 1928.

[13] Eisler, u. Kopstein: Röntgendiagnostik der Gallenblase. Leipzig, 1931.

[14] Kaufmann: Lehrbuch der pathologische Anatomie. Berlin u. Leipzig, 1922.

[15] Naunyn, B.: Die Gallensteine. Jena, 1921.

[16] Besanez, G.: Lehrb. d. physiol. Chemie, 1874; Quoted in Roberg, Sialolithiasis, ANNALS OF SURGERY, vol. xxxix, p. 669, 1904.

[17] Rosenthal, M.: Ein Beitrag zur Kenntnis der lithiasis pancreatica. Arch. f. Verdauungs Krankheiten, vol. xx, p. 619, 1914.

[18] Wilkie, A. L.: The Bacteriology of Cholecystitis: a Clinical and Experimental Study. Brit. J. of Surg., vol. xv, p. 450, 1928.

[19] Rous, P., McMaster, P. D., and Drury, D. R.: Causes of Gall-stone Formation. J. Exp. Med., vol. xxxix, p. 97, 1924.

[20] Lichtwitz, and Bock: Der Kalkgehalt der Gallenblase u. seine Bedeutung f. d. Bildung der Gallensteine. D. m. Woch., vol. xli, p. 1215, 1915.

[21] Andrews and Hrdina: Absorption of Calcium from the Gall-bladder. American Journal of Med. Sci., vol. clxxxi, p. 478.

[22] Osler: Principles and Practice of Medicine. Tenth Edition, 1925.

[23] Robb: Observations on Calcification of the Gall-bladder with the Presentation of a Case. Brit. J. of Surg., vol. xvi, p. 114, 1928.

[24] Fowler, W. F. Calcareous Changes of the Gall-bladder Wall. ANNALS OF SURGERY, vol. lxxviii, p. 623, 1923.

[25] Talbot, P.: Cholelithiasis: Notes on a Case with a Calcified Gall-bladder. Brit. J. of Surg., vol. viii, p. 533, 1920.

# GASTRIC ULCERS DEPENDENT UPON DIAPHRAGMATIC HERNIA

By Frank S. Mathews, M.D., and William MacFee, M.D.

of New York, N. Y.

FROM ST. LUKE'S HOSPITAL, NEW YORK

There have come under our observation two cases of demonstrated gastric ulcers which seem to be definitely dependent upon a diaphragmatic hernia. These cases initiated our interest in the subject and caused us to review cases of diaphragmatic hernia which have been observed in one or another department of the hospital. The two cases of ulcer which are here recorded possessed many points of similarity. The subject is presented for two reasons. First, the etiology of gastric ulcer is obscure and many factors have to be considered as having a bearing on the subject of etiology: such factors are age, sex, race, diet, vertical posture, nervous strain, and, we are here adding, diaphragmatic hernia. Second, an explanation must be sought for every case of secondary anæmia and we would suggest diaphragmatic hernia as a cause of the condition which might readily remain undiscovered, or, if the hernia were known to exist, might be considered only as a chance finding. For instance, we have seen a case discharged from the hospital with a diagnosis of secondary anæmia in which a perusal of the history shows that the patient was known to have a diaphragmatic hernia but nothing in the history suggested that those in charge considered the two conditions in any way related. One patient entered the hospital with a profound anæmia and a medium-sized fibroid. Naturally, the palpable tumor attracted attention, but there was no history of uterine bleeding. An X-ray examination showed a diaphragmatic hernia, though there was no X-ray evidence of ulcer in this case. Many blood counts were made in the course of several months, the lowest showing 1,200,000 red blood-cells and 19 per cent. hemoglobin. The patient improved under medical treatment but the stools regularly gave a 4 plus Guaiac test. The bleeding in such a case seems to be accounted for by a congestion of the mucous membrane due to a constriction in the hernia without the necessity of assuming a definite surgical type of ulcer.

In a list of fifteen patients reviewed with diaphragmatic hernia, it is of interest to note that they were all females, all but one fairly obese and their ages ranged from forty to fifty-eight years. We were disappointed in not being able to find a blood count in all cases but in the cases where it was recorded anæmias of various degrees were present, the most marked being in the patient mentioned above. In the absence of tests of the stools for blood, it is not, of course, possible to be sure that the anæmia was dependent upon the hernia.

517

Diaphragmatic hernia is no longer considered a surgical curiosity. Many of these hernias are discovered as a result of X-ray examinations and may be without symptoms. In other cases the symptomatology fairly definitely points to a hernia. In other cases symptoms are quite too vague to make the average clinician think of a diaphragmatic hernia. And in addition we would call attention to diaphragmatic hernia as an occasional cause of a secondary anæmia.

CASE I.—Mrs. M. B. F., aged sixty-two years. The significant points of her history were that she had been married thirty years, had had no children, and recently had gained in weight. There was no history of a disease of the digestive tract early in life.

Three years before coming under observation she noticed progressive weakness and loss of energy. Then she consulted a physician who found that she was quite anæmic. At that time digestive symptoms were lacking or at least indefinite. Even under treatment she grew weaker and the anæmia did not improve. Shortly before coming under observation in 1927, she began to have epigastric distress with occasional attacks of vomiting. She never noted tarry stools nor did she vomit blood. An earlier series of X-ray pictures gave no indication of gastric pathology. The X-rays taken at St. Luke's Hospital in 1927 showed abundant evidence of gastric deformity but were hard to interpret. There was a large residue in the stomach in six hours and a small pocket of bismuth was located at the cardia. This small mass disappeared before the emptying of the main portion of the stomach. Both carcinoma and ulcer were considered in the diagnosis. Hemoglobin ranged from 40 to 60 per cent. in the month
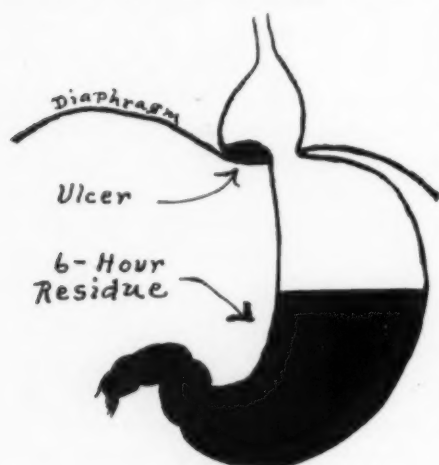


FIG. 1.—Diagramatic representation of X-ray condition in Case I.

preceding operation. In September, 1927, when the patient was sixty-two years of age, there was revealed by operation a diaphragmatic hernia with an ulcer of the lesser curvature of the stomach. There had at no time been characteristic ulcer symptoms. The œsophageal orifice in the diaphragm was about two inches in diameter and perhaps one-third of the stomach prolapsed into it and was with difficulty and only partially drawn down into the abdomen. A discreet mass was found at the lesser curvature. A strip of omentum turned up over the colon and stomach and was adherent to the mass. The omentum was first detached and then the stomach was drawn down with difficulty until the mass was entirely in the abdomen. A crater was then felt in the lesser curvature penetrating into the gastro-hepatic omentum. The mass was discreet and presented a hard margin with a central thinner portion. The diameter of the ulcer was thought to be about 2 centimetres. There were no large nodes and the condition was not thought malignant. Though the ulcer could be drawn out of the hernial ring, when the traction was relaxed, it re-entered it so as to be just within the grasp of the ring of the diaphragm. Resection of the ulcer was thought impossible and a gastroenterostomy was made because of the large six-hour gastric residue. The immediate convalescence was uneventful. The anæmia has greatly improved and the patient is now—four years later—practically free from symptoms.

The X-ray evidence in this case is lacking because the films were inflammable and have been destroyed. (Fig. 1.)

CASE II.—Mrs. S., a white woman, sixty-eight years old, was admitted to St. Luke's Hospital, December 15, 1930. Her chief complaints were a constant, dull pain in the right lower portion of the abdomen, weakness, and loss of appetite. These symptoms had been present about four months. About two and one-half months ago she was forced to take to her bed, where she has since remained. The pain, which is located in her right lower abdomen, radiates slightly upward and outward, and also downward in the direction of her bladder. She has, however, no urinary distress. The pain is of a constant, dull character, and tends to be worse in the afternoon and at night. It is not associated with nausea or vomiting, and has no relationship to the taking of food. The appetite has gradually become very poor. The patient has a distinct aversion to food of all kinds and has to force herself to eat. She has had considerable



FIG. 2.—Case II. Immediately after ingestion of bismuth.

FIG. 3.—Case II. Twenty-four hours after ingestion of bismuth.

gas in her stomach and intestines. Constipation has required the frequent use of cathartics and enemata. The patient estimates that she has lost about twenty pounds' weight since the onset of her illness. She now weighs 170 pounds.

*Early History.*—General health excellent. The patient remembers no serious illness. About five years ago she had an attack somewhat like the present one but it was of short duration. X-ray pictures of her stomach at that time showed that about half the stomach was above the diaphragm. Since this attack, she has had occasional attacks of "gaseous indigestion," but in general her appetite and digestion have been good.

The patient has two sons living and well. There is no history of operations nor of severe injury. She is definitely obese. The skin, conjunctivæ and mucous membranes are very pale.

*Lungs.*—Negative. The heart is slightly enlarged to the left and there is a squeaky systolic murmur at the apex. *Abdomen.*—Obese. No viscera are palpable. No mass is felt. Slight tenderness is present in the costovertebral angle of the right lumbar region. No tenderness elsewhere.

519

*December* 19, 1930.—*Cystoscopy.*—Cystoscopic examination shows moderate congestion at the trigone. The catheters pass easily to the kidney pelves. Röntgenogram with the catheters *in situ* shows the right pointing farther than usual toward the left side. Pyelogram reveals a normal right kidney pelvis.

*December* 23, 1930.—X-ray examination of the gastro-intestinal tract shows marked herniation of stomach through the inner aspect of the left diaphragm. At the site of the constriction there is considerable irregularity. It is difficult to determine whether this is due to an inflammatory condition in this region or whether it is the condition of a super-imposed new growth. At the sixth hour there still remains some fluid in the stomach. At the twenty-fourth hour a considerable amount of the medium remains in the irregular area mentioned above. There is also a trace in the stomach proper. At the seventy-second hour emptying is still incomplete.



Fig. 4.—Case II. A—Thoracic. B—Abdominal stomach. C—Omentum.

*December* 26, 1930.—Examination of the stomach, including the screen findings, shows the œsophagus directed somewhat to the left, emptying into the stomach above the diaphragm. There was no definite evidence of a diverticulum of the œsophagus at the time of this examination.

*Laboratory Findings.*—*December* 15, 1930, the urine showed nothing abnormal except a faint trace of albumen.

*December* 15, 1930.—Red blood-cells—3,500,000; hemoglobin, 53 per cent.; white blood-cells, 16,800; polymorphonuclears, 68; lymphocytes, 32.

*December* 18, 1930.—Blood urea nitrogen, 14.6 milligrams per 100 cubic centimetres. Blood sugar, 112 milligrams per 100 cubic centimetres.

*December* 28, 1930.—Stool for ova and parasites negative. Stool for blood, 1 plus (Guaiac).

*December* 30, 1930.—Gastric analysis, fasting contents only. Quantity of contents expressed—40 cubic centimetres.

*Mucus.*—Small amount, greenish, well mixed. *Blood.*—One plus, (Guaiac); free hydrochloric acid, 35; total acidity, 45. *Microscopic.*—Fat, none; pus, 4 plus; yeasts, present; boas-Oppler, none; sarcinae, none; food fragments, present.

*Clinical Course.*—The patient had an admission temperature of 101° F. (mouth) which persisted for one week with little change. It then gradually subsided to normal and remained so. The blood-pressure was systolic 120, diastolic 70. The marked secondary anæmia, the presence of blood in the stomach contents and in the stools, the relatively high acid contents of the fasting stomach, the unusual X-ray findings in the herniated stomach, and the absence of a demonstrable lesion elsewhere suggested the possibility of gastric ulcer. (Figs. 2 and 3.) The patient was, therefore, put on an ulcer diet (Bastedo). Some temporary improvement was obtained. Attempts to extend the diet to solid and semi-solid foods, however, led to a return of the anorexia and



FIG. 5.—Case II. A is on the ring of the diaphragm, the omentum having been removed.

eructations, with increased pain in the right lower abdomen. On one or two occasions there was some transient epigastric pain. During her stay in the hospital—sixty-nine days—the patient vomited only a few times.

In general, symptoms referable to the upper abdomen were minimal. The chief complaints remained the same: constant pain in the right lower abdomen radiating toward the suprapubic region, aversion to food, and weakness.

Operative repair of the hernia was considered but the patient was at no time in condition to warrant its undertaking.

February 20, 1931, the patient vomited a small amount of dark blood. February 22, 1931, there was profuse vomiting of blood followed by rapid collapse and death.

*Autopsy.*—At least half of the stomach was found herniated through the œsophageal opening of the diaphragm into the chest. The œsophageal ring was dilated to a diameter of eight centimetres. In addition to the stomach, a large part of the great omentum had passed through the œsophageal opening. (Fig. 4.) It lay like a band across the

anterior wall of the stomach. The free margin of the omentum was adherent to the pericardial sac and to the upper surface of the diaphragm. Its mid-portion was tightly adherent to a large, indurated area on the lesser curvature of the stomach at the point where the lesser curvature made contact with the medial crus of the œsophageal opening of the diaphragm. The entire stomach itself was rotated anteriorly and upward on its transverse axis. The liver had likewise been rotated somewhat and pulled medially by the gastrohepatic ligament. The right kidney was absent from its usual position and was found much nearer than usual to the mid-line. Apparently, it had participated in the general movement of the viscera toward the œsophageal hiatus.

The greater part of the stomach was easily reduced. The lesser curvature, however, was extremely adherent to the medial margin of the œsophageal hiatus. After its removal the stomach was found to have an ulcer at this point. The ulcer had pene-



Fig. 6.—Case II. Stomach laid open. Ulcer shown at A.

trated the stomach wall completely and had invaded deeply into the gastrohepatic ligament. (Figs. 5 and 6.) In the center of the ulcer a blood clot was found projecting from a vessel which presumably had been the source of hæmorrhage.

The kidneys were adherent to their capsules and showed the changes of chronic interstitial nephritis. The ureters were normal.

No notable pathologic changes of consequence were present in the other abdominal viscera, except one free stone in the gall-bladder.

The principal points of interest in this case are:

(1) The existence of a diaphragmatic hernia containing a large part of the stomach which was the seat of an extensive ulcer. Few of the symptoms usually attributed to either condition were present.

(2) The principal complaint was that of pain in the right lower abdomen radiating along the general course of the right ureter. A possible explana-

tion of this symptom is to be found in the medial displacement of the right kidney.

(3) The most outstanding symptom attributable to the stomach was anorexia.

(4) The profound weakness was to be explained by anæmia and by malnutrition. Adipose tissue, however, was surprisingly well preserved.

The two cases here presented had a number of conditions in common. They were both fat women, past sixty years of age, without symptoms particularly suggesting ulcer. Each, however, had an ulcer which caused bleeding. In each case a tongue of omentum crossed the stomach and was attached to the ulcer base. The position of the ulcer in each case was at the lesser curvature and located at the point where the lesser curvature was in contact with the constricting margin of the diaphragm. It seems reasonable to suppose, then, that the diaphragmatic hernia was responsible not only for an ulcer but for its location in the stomach. In other cases like the one to which we have referred above, the congestion due to the constriction of the diaphragm has caused mucosal bleeding without going on to the formation of actual ulcers.

Since submitting the title of this paper to the provisional program of the association, we have seen two recent papers in the literature calling attention to gastric bleeding in association with diaphragmatic hernia. One is by Harrington on Diaphragmatic Hernia Associated with Traumatic Gastric Erosion and Ulcer, Surg., Gynec., and Obstet., vol. li, No. 4, p. 504, Oct., 1930. The other, by Segal, is entitled, Secondary Anæmia Associated with Diaphragmatic Hernia, New York State Journal of Medicine, vol. xxxi, No. 11, p. 692, June 1, 1931.

The two cases here recorded have demonstrated actual ulcers and have left little doubt in the minds of the writers that the ulcers were definitely dependent upon the diaphragmatic hernia.

### CONCLUSIONS

(1) Diaphragmatic hernia may be the cause of gastric erosion or actual ulcer.

(2) The ulcers, at least in the two cases here recorded, have lacked the symptoms which usually suggest an ulcer of the stomach.

(3) In a woman who is obese, past middle life, and suffering from a secondary anæmia—especially if a stool examination for blood is positive—a hernia of the diaphragm should be considered as a possible cause.

# TUMORS OF THE DIAPHRAGM

## By Horace Binney, M.D.

of Boston, Mass.

ALTHOUGH in recent years improved radiologic technic has made possible the more frequent recognition of hernia of the diaphragm and caused among surgeons an increased interest in this organ, as yet there has been hardly any mention in the literature of primary tumors of the diaphragm. A search in the literature of the past fifty years reveals but four instances of primary tumor, two of which were discovered at operation and two postmortem. The reports of these are as follows:

CASE I.—BONAMY, in 1912, reported a case of multiple fibromyoma. A woman of thirty-four, otherwise well, had noticed for some months a swelling in the right hypochondrium which had recently increased in size. It was situated along the lower margins of the eighth, ninth, and tenth costal cartilages, was dull on percussion, globular in form, and appeared continuous with the liver. It was apparently fluctuant and was diagnosed as an hydatid cyst. At operation, an incision was made in the right hypochondrium over the middle of the tumor, and a large, bluish-white mass was found extending under the costal cartilages toward the xyphoid cartilage. Puncture revealing no fluid, the mass was freed and found to be attached to the diaphragm by a pedicle. It was easily enucleated; then four other smaller ones were found and enucleated. Together they weighed 1,200 grams. Histologic examination showed firm connective tissue with a few striated muscle fibres. The patient had a normal recovery.

CASE II.—SAUERBRUCH, in his textbook on surgery of the chest, reports briefly the case of a woman, forty-three years of age, upon whom he operated in 1913 for a tumor in the left hypochondrium. It apparently was the cause of abdominal pain, rather indefinite in character, projected below the costal margin on inspiration, and tended to disappear with expiration. In removing it, the eighth, ninth, and tenth ribs were resected. The tumor was found to be a fibromyosarcoma of the diaphragm. The patient recovered and "remained free from recurrence."

CASE III.—Of the two primary tumors discovered at autopsy, one was a sarcoma, reported by DALZELL in 1887. It occurred in a woman of forty-two years who died three weeks following a fracture of the shaft of the femur, the result of a metastatic deposit in the bone. At autopsy the right half of the diaphragm was more or less replaced by a mass measuring 1½ to 2 inches in thickness, adherent to and somewhat infiltrating the under surface of the lung. There were secondary nodules in the liver, two tumors in the skull, and one at the seat of fracture of the femur. Microscopically, the primary and secondary tumors were of the same character, masses of small round cells in a fibrous meshwork—evidently a round-cell sarcoma.

CASE IV.—CLARK, also in 1887, reported a lipoma of small size, discovered at autopsy in a woman of sixty-five.

My interest in this subject was aroused by the following experience:

AUTHOR'S CASE.—In October, 1929, I was asked to see in consultation a male patient in the medical wards of the Boston City Hospital. He was fifty-eight years of age and had a negative previous history except that two years before he had taken a trip to South America. His present illness began five months before entrance with

Fig. 1.—Tumors of upper lobe right lung and apparently of right lobe of liver.
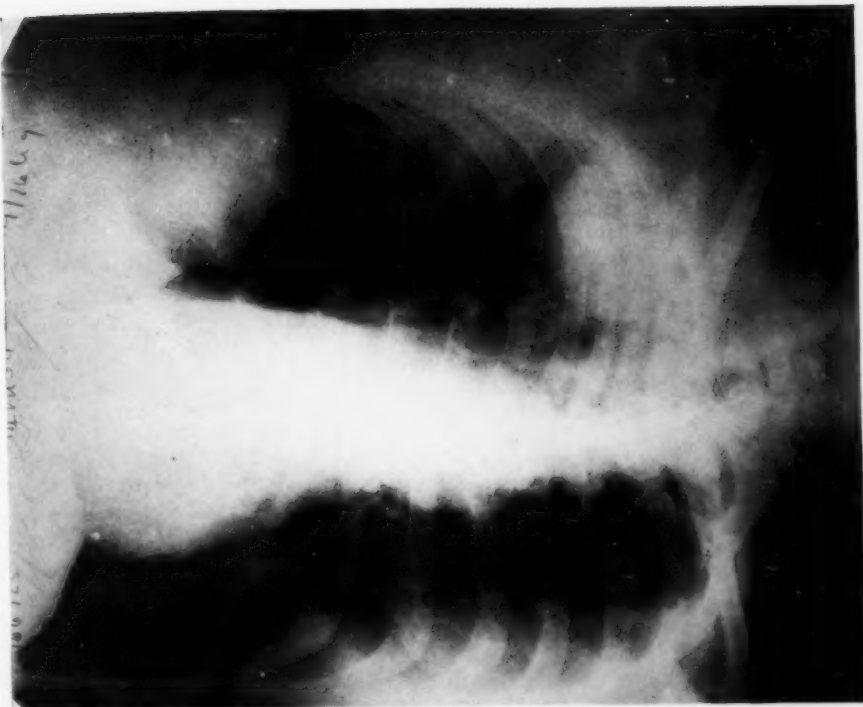


Fig. 2.— Pneumo-peritoneum, showing cupola of right diaphragm above liver (?) shadow.

intermittent attacks of pain in the upper and inner aspect of his right arm. Physical examination was generally negative but examination of the chest showed a small area of dullness and diminished respiration in the mid-clavicular line from the second to the fourth ribs on the right side. An X-ray examination of the chest showed a rounded area of density in the same region of the upper lobe of the right lung, and marked elevation of the right diaphragm. (See Fig. 1.) This latter shadow gave the impression of a rounded tumor below the diaphragm. At this time there were brief spells of coughing and the raising of a little mucus. The sputum was negative for tuberculosis, the blood picture was normal and the Wassermann test negative. There had been no loss of weight.

The signs in the upper chest, and X-ray picture suggested a tumor in the lung, but the evident tumor in the liver and the history of having visited tropical countries pointed to the possible diagnosis of echinococcus disease of lung and liver. An effort to obtain material for a complement fixation test was unsuccessful. On consulting the literature of echinococcus disease I found that a combination of liver and lung hydatids is more common than any other two foci, occurring in about 20 per cent. of cases involving the liver, and that pain in the arm and shoulder sometimes occurs in liver cysts. In this case, therefore, we concluded that the pain was reflex through the phrenic nerve, resulting from pressure on the diaphragm by the enlarged liver.

To determine the relation of the diaphragm to the liver shadow pneumo-peritoneum was carried out, 100 cubic centimetres of air being injected, and fluoroscopic examination made at once in the sitting position. The air bubble appeared distinct between liver and diaphragm (see Fig. 2), the latter appearing high but freely moveable. While this examination was being carried out the patient remarked that his pain was entirely gone. As none of the novocaine had been injected into the peritoneal cavity, we concluded that the liver tumor was the cause of his symptoms, and operation was advised. Accordingly, on October 24, 1929, laparotomy was performed under spinal anæsthesia. On exposing the liver, it was found to be cirrhotic, the surface much roughened and grayish in color. No cyst or tumor of the liver was present, but beneath the posterior part of the right diaphragm was felt a hard, nodular mass about 4 by 10 centimetres in size, evidently growing in the diaphragm and projecting somewhat from its inferior surface. As the growth was obviously malignant and secondary to the tumor in the lung, and could not be excised by the abdominal route, a small piece only was removed with the aid of the electric cautery, which proved on microscopic examination to be carcinoma.

The patient was relieved of his symptoms following the operation for about two weeks. On the return of pain, phrenicotomy was performed with partial relief only. X-ray treatment was begun, but soon a swelling appeared beneath the right clavicle, evidently an extension of the lung carcinoma into the chest-wall. This caused increased pain in the whole arm and demanded an alcohol injection of the brachial plexus for relief. The patient was then transferred to the State Hospital for Cancer where it was hoped he might obtain further relief by special X-ray therapy, but he rapidly weakened and died in January, 1930. Autopsy showed the lung tumor to be a carcinoma of bronchial origin, and the tumor of the diaphragm to be secondary.

*Diagnosis.*—The lack of any characteristic symptoms will probably prevent the diagnosis being made in most cases of primary tumor. Secondary involvement occurring in tumors of the chest-wall will often be suspected by the size and position of the tumor, if not demonstrated by X-ray before operation. Hedblom, in 1922, analyzed a list combined of cases in the literature and from the Mayo Clinic—a total of eighty-four cases—in which the diaphragm was found involved and was resected to a greater or less extent

in twelve. This gives an incidence of secondary tumor of the diaphragm of about 14 per cent. in malignant chest-wall tumors. Of the four primary cases which I have quoted, two presented below the rib margin and were easily palpable, but the suggestion in Bonamy's case was a cyst of the liver, and in Sauerbruch's a tumor of the spleen. In the latter case, the effect of respiration in causing the tumor to retract on expiration would seem, in retrospect, to suggest attachment to the diaphragm.

Secondary tumors, due to other conditions than those of the chest-wall, will rarely be of surgical importance and operable. With our present means of diagnosis, their discovery will also be improbable unless, as in my case, reflex pain through the phrenic nerve suggested an X-ray of the chest, and, unlike my case, the tumor gave a clear shadow by X-ray. If situated high enough in the diaphragm, that is, near its centre, pneumo-peritoneum would throw the tumor into relief, and, as suggested by Lilienthal, differentiate it from a tumor of the liver.

*Treatment.*—A primary tumor presenting below the costal margin, developing from the inferior surface of the diaphragm is evidently easily removed by abdominal or abdomino-thoracic operation. In case of a more central tumor being discovered by X-ray, since primary malignant disease does occur, the approach should be thoracic and a wide resection carried out.

The methods of closure of the resulting defect in the diaphragm are various, depending on its size and position. In case of large defects, suture of margin to lung or liver has given excellent results in operations for chest-wall tumors. The ideal method would seem to be the use of a fascia lata transplant as employed by Lilienthal in a traumatic rupture of the diaphragm.

# SYMPTOMS AND PHYSICAL SIGNS INDICATING HERNIA OF THE DIAPHRAGM WITH REPORT OF TWELVE CASES TREATED BY OPERATION

## By Philemon E. Truesdale, M.D.

of Fall River, Mass.

The symptoms of hernia of the diaphragm are odd because of their variety and complexity. Occurring with so many other affections, they readily admit of erroneous interpretation. So fantastic are the chest symptoms and physical signs that a competent internist interpreted his observations in Case I as moderately advanced pulmonary tuberculosis. By others, the attacks of cyanosis were thought to be due to heart disease and the cough to bronchitis. In Case V the prevailing pre-operative opinion was indigestion, obstinate constipation, and later, acute obstruction, probably intussusception. In Case VI the attacks of cough and cyanosis were attributed to pertussis. In Case VII gastro-intestinal upsets were thought to be due to dietary errors. In Case VIII the last physician called, one of six, alone suggested a Röntgen-ray study. This evidence is indicative of failure to consider the possible presence of hernia of the diaphragm from the history and physical examination. In Case XII, for example, the patient was found in a tuberculosis sanitarium. She had been sent there by examiners in one of our state clinics.

In adults the clinical picture of diaphragmatic hernia is often so bizarre and bears resemblance so closely to the symptoms of other diseases of the heart, lungs, stomach, gall-bladder, and intestines that this deformity is not among the examiner's thoughts when he makes the diagnosis by elimination. In infants cyanosis is so often a manifestation of enlarged thymus or congenital heart disease that any other cause is seldom considered. Yet cyanosis is an invariable accompaniment of congenital hernia of the diaphragm and differs clinically from that due to enlarged thymus and heart disease. It is less constant, occurs in attacks, is more likely to appear with crying spells, and is promptly relieved by passing a stomach tube or by changing the patient's posture from the recumbent to the erect. The cough associated with congenital hernia of the diaphragm is peculiar. It may be mistaken for bronchitis, pneumonia, or whooping-cough. It is usually unproductive. When it comes on in paroxysms, it seldom ends with vomiting, is invariably relieved by putting the patient upright, and lacks the characteristic "whoop" of pertussis.

Hernia is sometimes confused with eventration of the diaphragm. Case VIII came to us with the diagnosis of eventration. It may be found extremely difficult or impossible to differentiate the outline of a high diaphragm because of its thin walls. The graceful curve of a rib margin may be mistaken for the diaphragm line. However, with the aid of the Bucky diaphragm the

528

technic may suffice for differentiation. Furthermore, the diaphragm may be found at different levels when hernia exists. In some instances the ascent of hollow viscera of the abdomen may elevate the diaphragm to a level higher than normal and keep it there. In others the diaphragm with its hernia may vary but little from its normal level, while in a third group the transposed stomach and intestines when distended may noticeably depress the diaphragm. In Case I, for example, the dome of the diaphragm was found at a level below the crest of the ilium.

*Physical Signs.*—With partial or complete collapse of one lung, compression of the other, shift of the mediastinum, and occupancy of the pleural cavity by the hollow viscera of the abdomen, it is not easy to find a more fantastic picture than that of diaphragmatic hernia. Though the presence of a small portion of the stomach in the thorax may reveal nothing unusual on examination, herniæ of large proportions present anatomic variations which are significant and outstanding, though quite variable.

On the afflicted side there may be dullness or a flat percussion note with a variety of râles, suggesting the presence of pneumonia. Lockwood states that when actual compression of the lung takes place, the note becomes progressively dull and breathing approaches the bronchial type. The physical signs, however, may not be the same at any two examinations, since they necessarily vary according to the amount of food, water, or air in the stomach and bowel. Not only do the signs on auscultation and percussion vary with the amount and character of contents of the transposed stomach and bowel, but also with the position of the patient. Fluid in the bowel or stomach or both manifests signs which have been mistaken for pleuritic effusion. So positive were signs of fluid in Case I that preparations were made to insert a needle. When the moment came to act, the signs had changed indicating air instead of fluid in the chest.

At one time the physical signs simulate pneumothorax, at another hydrothorax, and at still another hydropneumothorax. Sounds over an empty stomach may be tympanitic or cavernous suggesting a tuberculous lung cavity. In Case XII physical signs resembling those of pulmonary tuberculosis could be differentiated readily after the Röntgen-ray demonstrated the presence of the colon in the left pleural cavity. In spite of many vagaries presented, however, the herniated viscera show important signs somewhat easy of interpretation if the examiner's mind is receptive. The affected side of the chest is prominent and restricted in range of motion. The outward flaring of the margin of the subcostal angle due to loss of pull by the diaphragm against the scalene and intercostal muscles is often observed. Litten's sign, the diaphragmatic shadow, is absent. The abdomen may be scaphoid to a degree depending upon the extent of hollow viscera displaced. Dextrocardia is always present in some degree in hernia on the left side. If not positive evidence of diaphragmatic hernia, it is a very important symptom when considered with other signs. Heart displacement may be slight or extreme. If

34

the stomach is in the left pleural cavity, the position of the heart will depend upon the amount of food or gas in the stomach.

On auscultation there is a mixture of sounds. When collapse of the lung is complete or nearly so, there may be an entire absence of breath sounds on the affected side. Instead, sonorous râles are heard. To one accustomed to listening over the abdomen, they sound similar to those heard in chronic intestinal obstruction, as gurgling, blowing, metallic sounds synchronous with peristalsis. These sounds may be heard high in the chest cavity indicating definitely that they are not transmitted from below the diaphragm.

Finally, the all-important agent of examination, the Röntgen-ray, is brought into play. A series of röntgenograms after the opaque meal removes nearly if not all doubt about the position of the stomach and intestines. A barium enema in addition to the bismuth meal should be included in the examination. It is always important to define the location of the colon. The use of the fluoroscope greatly aids in the study of the transposed organs.

*Treatment.*—A vast amount of investigation is necessary to obtain evidence upon the incidence of diaphragmatic hernia. That it sometimes exists throughout life without causing symptoms has been demonstrated at post-mortem examinations; that it has been discovered at autopsy as an obscure and unrecognized cause of symptoms is also well known, and that it is frequently unidentified and treated from infancy to old age for a variety of better-known ailments is one of the features of the anomaly.

Since the manifestations of diaphragmatic hernia are as variable as the form of hernia itself, medical treatment is usually symptomatic. Though some form of medication may be indicated, it is a mistake to administer drugs to stimulate the heart or respiration. Such treatment within all probability will aggravate discomfort. Bearing in mind the mechanic effects produced by the transposed hollow viscera involved in the hernia and the tendency for peristalsis to be impeded at the aperture in the diaphragm, it is natural to infer that a reduction in the volume of gas contained in the stomach and colon would afford immediate relief. This may be accomplished, first, by placing the child in upright posture and later, if necessary, by passing a stomach tube or rectal tube or both. In infants and young children a rubber catheter serves the purpose of a stomach tube. An ordinary enema will usually deflate the colon. Regulation of diet helps most patients whether young or old. Antifermentatives may be used to advantage. When drugs and diet fail, the rubber tube can be relied upon to afford instant relief, though it is but temporary.

In a consideration of the indications for an operation of repair, certain precedents governing the treatment of hernia elsewhere may be applied. Hernia at the umbilicus or inguinal region appearing soon after birth is due to developmental failure. Some defects close and remain so permanently. Others close partially or not at all, thus leaving a gap in the supporting layers of the abdominal wall, protected only by a thin serous membrane lining the skin. Hernia develops. If uncomplicated, it is treated expectantly

and disappears. Many of these, however, remain potential herniæ and return in later life when sudden and forceful intra-abdominal pressure is applied. So far, hernia through the abdominal wall is not unlike hernia through the diaphragm. The former always has a sac formed by the peritoneum. Therefore it is a true congenital hernia. Diaphragmatic hernia may have its origin in a serous sac. But from external violence this sac may be stretched or may rupture, immediately converting a true hernia into a false hernia. Moreover, owing to failure of fusion of the segments of the diaphragm during embryonic life, an extensive false hernia may exist at birth. A small hernia of the stomach involving only its cardiac end and passing in and out of a small serous sac, may cause no more trouble than a relaxed inguinal ring. As it increases in proportions, however, it becomes more of a clinical problem. It cannot be held back with a truss. It is not always operable. The hernial ring in the diaphragm is not thick and fibrous. It is a bit more elastic. Although it impedes peristalsis, it rarely blocks the arterial blood supply. The operation for uncomplicated umbilical and inguinal hernia in the adult is neither difficult nor dangerous at any time of life, whereas an operation on the diaphragm invariably assumes major proportions. In these respects, the two types of hernia differ. Our experience has led to the belief that operation for hernia of the diaphragm is more easily and more safely treated before the adolescent period of life.

*Preparation of the Patient for Operation.*—Before operation is undertaken, a complete physical examination of adults should be made by an internist, and of children by a pediatrician and an internist. There should be careful inspection for other congenital defects. Study of the röntgenograms of young children should be made with a view to determining the possible presence of an enlarged thymus. Blood, urine, and stool determinations should be included in the evidence.

It is important to exercise the utmost care in minimizing the wear and tear of exhaustive investigations on very young patients. Young children are easily overtaxed and their resistance lowered to the danger point without a realization of this on the part of the examiner. They should be spared unnecessary examinations and needless handling. The variety of Röntgen-ray films which can be taken to perfect a study of the new relationships of transposed organs is legion. Necessity demands careful study of the patient, but it is well to bear in mind that examinations which are carried to excess can result in compromising success of an operation. It is desirable also to postpone operation for a few days after the general examination is completed. During this period there will be opportunity to clear the gastro-intestinal tract of all particles of barium and reëstablish normal physiologic rest and diet.

*Anæsthesia.*—We have employed gas-oxygen-ether anæsthesia during our operations. It is administered under pressure to obviate the risk of asphyxia. To this we attribute our success in the first case, and credit is due the anæsthetist, Miss A. M. Hunt, for the adoption of this method in 1921 without suggestion on my part. Dr. Albert H. Miller, our director of anæsthesia,

531

employed a pressure apparatus of his own design in Cases VII, VIII, and IX of our series. Respiration was maintained throughout the operation in such a manner as to facilitate the operation, enhance recovery, and maintain convalescence without the occurrence of pleuritic effusion.

In Case XI we have an illustration of the difficulties arising from the use of an anæsthetic which does not give muscular relaxation when needed. It is natural to ask why there should be muscular relaxation during operation by the intercostal approach. The operator's experience in this case is an answer to the query. Patient XII was operated upon at the Veterans' Hospital in Washington, D. C. Associated with the writer was Dr. James F. Mitchell. During the operation we found reduction of the herniated stomach and intestines exceedingly difficult. Whenever the stomach was reduced the intestines were forced back into the thoracic cage. An attempt then made to reduce the intestines resulted in the return of the stomach to its former position above the diaphragm.

This is a very discouraging phenomenon and may force the surgeon to abandon the operation. The repetition of this obstacle proved distressing until a simple explanation suggested itself. Gas-oxygen-ethylene was the combination anæsthesia employed. Although the abdominal muscles were remote from the field of operation, their rigidity compressed the abdominal wall and re-



FIG. 1.—A right-angle adjustable seat on the operating table, supporting the patient in a sitting position.

duced the capacity of the abdomen. Ether was substituted for ethylene whereupon the abdominal wall relaxed, the cavity enlarged, and the transposed viscera found adequate room when returned to the abdomen and remained there. The loss of time and the strain upon the patient may have been a contributory factor in the development of post-operative pneumonia. If so, it was a costly lesson which afforded the opportunity for an observation of no little value. Spinal anæsthesia has been suggested, but its effects on respiration already crippled are not devoid of added risk.

*The Operation.*—In approaching the diaphragm the aperture in the chest

wall is made large enough to permit easy access to the hernia. A sufficient number of successful operations by the intra-thoracic route are reported to indicate our preference of this method. Many surgeons use the abdominal approach by choice as a less disquieting means of access because it is a more familiar operation. Before deciding upon a method of approach, however, it is advisable to study in each case the patient's architecture and the conditions likely to be met above and below the diaphragm.

In thoracotomy the patient is placed on the table at an angle of 45° with the field of operation at the desired level. When operating upon children, to prevent sliding, the patient is seated on a right-angled support firmly
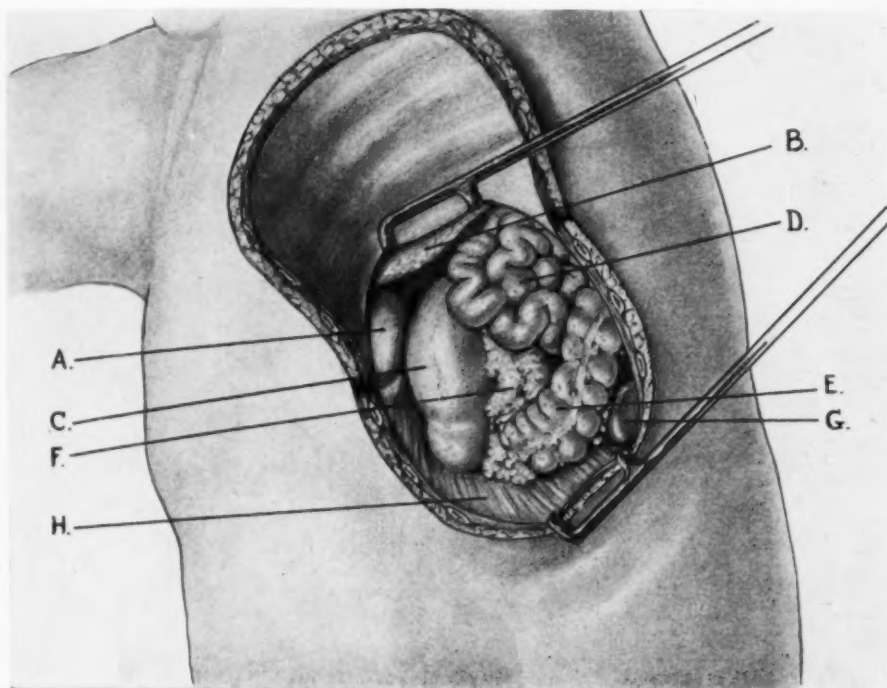


FIG. 2.—Exposing contents of pleural cavity through a lapel incision. A—Heart. B—Left Lung. C—Stomach. D—Small intestine. E—Colon. F—Omentum. G—Spleen. H—Diaphragm.

adjusted upon the operating table. (Fig. 1.) A lapel incision is carried down through the skin, fascia, and muscles, exposing the ribs. After opening the pleura a grooved shield director is employed to protect the small bowel. Coils of intestines are forced out of the pleural cavity by positive intra-thoracic pressure. To retain these hollow viscera within the thoracic cavity the use of walling-off sponges becomes necessary. The ribs are severed at the anterior and posterior extremities of the incision. The flap thus made contains all layers of the thoracic wall and is turned upward on its base.

In Fig. 2 the flap is shown spread open to a degree permitting the operator to use both hands in the thorax. In the field can be seen (A) the apex of

the heart, (B) the left lung, (C) the stomach, (D) the small intestine, (E) the colon, (F) the omentum, (G) the spleen, and (H) the diaphragm.

At this stage in the operation an important step is the anæsthetization of the phrenic nerve to release tension and immobilize the diaphragm. The nerve is displaced outward and rendered taut by the use of a hook. A 2 per cent. solution of novacaine is injected into the nerve sheath. (Fig. 3.) A disturbing element in the operation is the continued action of the heart, lung, and diaphragm. Reduction of the herniated organs is greatly facilitated if any one of these embarrassing factors is controlled.

After a general survey of the field, observations may be made on the posi-
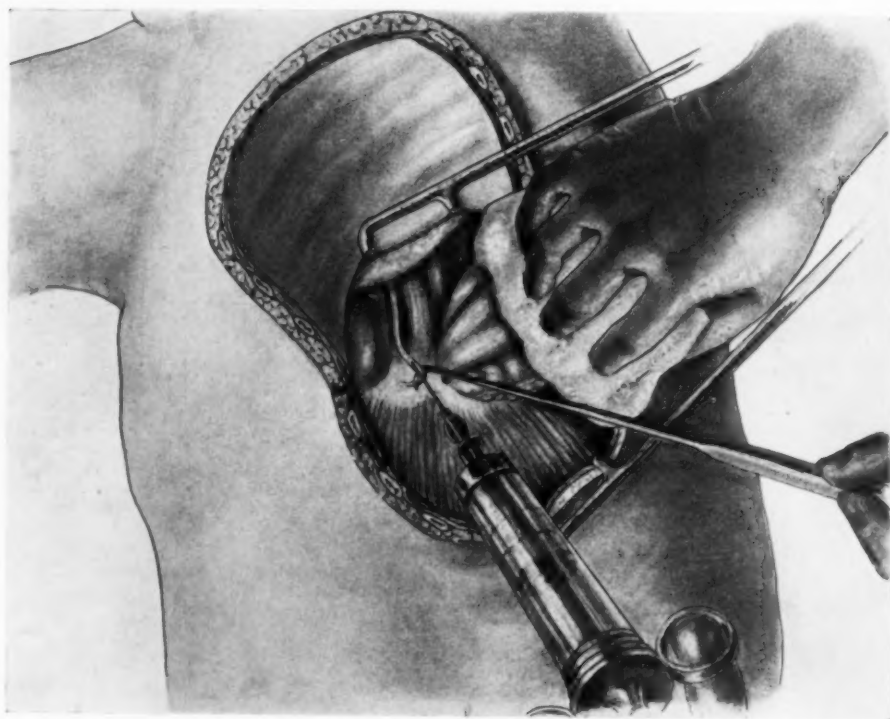


Fig. 3.—Injecting the phrenic nerve with 2 per cent. novocaine.

tion of the heart, the degree of lung collapse, and the condition of all the organs involved in the hernia, such as the degree of distention of the hollow viscera, color of the visceral peritoneum, and adhesions which are likely to prove barriers to reduction. Finally the aperture in the diaphragm should be examined as to its location and size. If there is impaction of those structures which have passed upward from the abdomen, the opening is enlarged by an incision beginning at its outer circumference and extending laterally parallel with the muscle fibres for from 5 to 7 centimetres. The edges of the opening are then held back. The enlarged aperture greatly facilitates the chore of tucking the hollow viscera back into the abdomen.

When reduction has been accomplished, the opening in the diaphragm is closed from without inward if the orifice is paracesophageal and from within outward if the opening involves the periphery of the diaphragm. A running suture of silk is used reinforced by 2 or 3 mattress sutures of the same material. Catgut is less dependable. It softens, swells, and may yield as a result of tension and constant motion of the diaphragm. In Case VI silk was used. The patient developed an empyema after operation. Free drainage was necessary for two or three weeks. Although this exudate covered the diaphragm, the silk suture material held and there was no recurrence of the hernia.

In closing the chest wall, the flap is turned down and sutured in place with silkworm gut. (Fig. 4.) The first of these sutures is used at the centre of the thoracotomy wound and includes the rib above and the rib below the incision. The remainder are inserted at close intervals in such a manner as to approximate the cut edges of the pleura and bring into apposition the severed ends of the ribs. Before the last suture is ligated the lung above is expanded by $CO_2$ inhalations until it approaches the diaphragm. These inhalations are repeated at four-hour intervals for the first forty-eight hours after operation.

Since the diaphragm is in a state of constant activity, during the early convalescence of the



FIG. 4.—Thoracotomy incision closed with interrupted sutures of silkworm gut.

patient elimination of pressure against its under surface is important. To bring this about, a stomach tube is passed at the close of the operation and an indwelling rectal tube employed for three days.

*Summary of Results.*—The accompanying chart is a report in brief of twelve operative cases. Nine were upon children under tweve years of age and three were upon adults. It is very likely that all of the herniæ were of congenital origin. Four developed to major proportions from automobile accidents and three from external violence of less degree. The remaining five gave no history of injury. Before admission the condition was thought to be pulmonary tuberculosis in two cases, intussusception in one, whooping-cough in one, congenital heart disease in one, cholecystitis in two, and improper feeding in two. In this series, nine in number, there was no death after operation in children. One adult died on the seventh day from pneumonia.

DISCUSSION: DR. DANIEL F. JONES (Boston, Massachusetts) said that he had had two cases of bleeding, which he supposed to be due to diaphragmatic hernia. He operated on

CHART

| Case | Name | Age | Sex | Other Birth Anomalies | Type | Side | Site | Cause | Duration | Dominant Symptoms | Mistaken For | Diagnosis Made by | Operation | Operative Approach | Contents | Anaesthesia | Result | End Result and Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Leonard Stone | 5 yrs | M | None | Traumatic (False) | Left | Para-esophageal | Motor car | 9 mos | Cough Cyanosis | Pulmonary tuberculosis | Stethoscope | Feb 23, 1921 | Thoracotomy | Stomach Spleen Left lobe of Liver Small intestine Colon | Pressure Gas Oxygen Ether | Recovery | Recurrence |
| 2 | Leonard Stone | 6 yrs | M | None | Recurring (False) | Left | In scar | Coasting | 2 mos | Intestinal obstruction | | X-ray | Cecostomy Dec 1, 1921 Repair Jan 19, 1922 | Thoracotomy | Transverse colon | Pressure Gas Oxygen Ether | Recovery | Recurrence |
| 3 | Leonard Stone | 7 yrs | M | None | Recurring (False) | Left | In scar | Coasting | 3 days | Intestinal obstruction | | X-ray | Cecostomy Nov 20, 1922 Repair Dec 5, 1922 | Thoracotomy | Transverse colon | Pressure Gas Oxygen Ether | Recovery | Recurrence |
| 4 | Leonard Stone | 8 yrs | M | None | Recurring (False) | Left | In scar | | 2 days | Intestinal obstruction | | X-ray | Cecostomy Apr 10, 1924 Repair Apr 23, 1924 | Thoracotomy | Transverse colon | Pressure Gas Oxygen Ether | Recovery | No further recurrence 7 yrs |
| 5 | Alice Brown | 6 yrs | F | None | Traumatic (False) | Left | Foramen Bochdalek | Coasting | 12 mos | Intestinal obstruction | Intussus-ception | Exploratory operation | Preliminary Appendicostomy Apr 26, 1926 | Thoraco-peritoneal Apr 26, 1926 | Colon | Pressure Gas Oxygen Ether | Recovery | 3 failures after laparotomy |
| 6 | Anna Cifelli | 5 yrs | F | Harelip | Traumatic (False) | Left | Para-esophageal | Motor car | 2 mos | Cough Cyanosis | Whooping Cough | X-ray | May 18, 1928 | Thoracotomy | Stomach Spleen Small intestine Colon | Pressure Gas Oxygen Ether | Recovery | Well |
| 7 | Lydia Messier | 52 yrs | F | None | Congenital (True) | Left | Esophageal | Develop-mental | Years | Gastric | Gall Stones | X-ray | Repair Dec 7, 1929 | Thoracotomy | Stomach | Pressure Gas Oxygen Ether | Recovery | Well |
| 8 | Pauline Lewis | 1 yr | F | None | Congenital (False) | Left | Esophageal | Develop-mental | Since birth | Paroxysms of coughing, Gastric Bronchitis | Improper feeding | X-ray | Repair Jan 21, 1930 | Thoracotomy | Stomach Spleen | Pressure Gas Oxygen Ether | Recovery | Well |
| 9 | Diane Stone | 1½ yrs | F | None | Congenital (False) | Left | Foramen Bochdalek | Develop-mental | Since birth | Cough Abdominal pain and distention from intestinal obstruction | Improper feeding | X-ray | Cecostomy July 28, 1930 Repair Aug 4, 1930 | Thoracotomy | Stomach Colon Small intestine Rudimentary lung | Pressure Gas Oxygen Ether | Recovery | Well |
| 10 | Helen Waldron | 52 yrs | F | None | Congenital (True) | Left | Esophageal | Develop-mental | Years | Gastric | Neurasthenia Cholecystitis | X-ray | Excision of Gastric ulcer Oct 11, 1930 Repair Oct 27, 1930 | Laparotomy for Stomach ulcer Thoracotomy for hernia | Stomach | Pressure Gas Oxygen Ether | Recovery | Hernia co-existing with gastric ulcer |
| 11 | Charles Frates | 34 yrs | M | None | Traumatic (False) | Left | Esophageal | Motor car | 14 mos | Cough Dyspnea Chest pain Epigastric pain Strangling | | X-ray | Repair Nov 15, 1930 | Thoracotomy | Stomach Small intestine Colon | Pressure Gas Oxygen Ether | Died 7th day Pneumonia | |
| 12 | Lega Gouveia | 12 yrs | F | None | Congenital (False) | Left | Foramen Bochdalek | Develop-mental | Since birth | Cough Epigastric pain | Pulmonary tuberculosis | X-ray | Jan 30, 1931 | Thoracotomy | Small intestine Colon | Pressure Gas Oxygen Ether | Recovery | Well |

those two patients but was unable to find any cause for the bleeding. There was absolutely no thickening, no callousing of the peritoneum, and no indication that there was, or ever had been, an ulcer in either case. And yet in one, marked anæmia had been present for fifteen years. In the second case anæmia had been present for something over two years, with a serious hæmorrhage about two months before operation.

This caused a good deal of discussion in Boston for some time, with one of the medical men insisting that the bleeding was due to the diaphragmatic hernia. In both cases the opening in the hernia was very large, the full width of the hernia itself. The hernia was not a large one.

In cases of diaphragmatic hernia he had only attempted operation on those with callousing of the stomach which showed that the stomach had been rubbed in going up and down, or in kinking of the œsophagus. It is difficult for him to believe that the first case, where the patient had anæmia for fifteen years, was due to congestion because one cannot imagine a woman having congestion steadily for fifteen years without any evidence of it on the stomach in any way. There was absolutely no thickening of the peritoneum, nor was there any ulcer of the lower end of the œsophagus which might be the cause of it.

Thus Doctor Mathews' experience is exactly the opposite. On two cases operated upon, two definite ulcers were found. The cases of Doctor Jones were gone over very carefully from the duodenum to the œsophagus, there was absolutely nothing found to cause the bleeding, and yet one must admit that probably the bleeding was due to the diaphragmatic hernia, as has been shown in a number of cases since.

DR. FRANCIS A. C. SCRIMGER (Montreal, Canada) referred to an experience with one fairly recent case which was entirely in agreement with that found in Doctor Mathews' case. It was a boy of about fourteen. He had a long history of recurring attacks of pain and vomiting. The Roentgen-ray examination revealed a pit that was taken to be an ulcer just at the level above the diaphragm. He was suffering pain and had recurring attacks of vomiting. An attempt was made to reduce it by the abdominal route using a Marwedel incision, but the attempt entirely failed. The bowel was brought down without great difficulty into the abdomen and the enlarged hiatus sutured. The diaphragmatic portion was way over to the right side, in the form that Doctor Jones has spoken of. It held for four days and then something occurred and there was a recurrence of the vomiting. Subsequent X-ray pictures showed that the hernia had recurred. The ulcer was exactly at the point where the pressure of the opening through the diaphram came.

DR. HOMER J. WOOLSEY (San Francisco, California) called attention to the fact that in Doctor Mathews' cases herniæ occurred in people who were forty years or over. Likewise, in the literature where the statistics are sufficient from which to draw any conclusions, the majority of the cases of diaphragmatic hernia in the œsophageal orifice are people of forty years or over. They all have a hernia sac, which is in direct contrast to the herniæ of the diaphragm that are met with in children, or in traumatic herniæ where there is a tear of the diaphragm.

There had been during the last four years in his clinic fifteen to twenty patients who had been discovered by Roentgen-ray to have herniæ of the stomach through the œsophageal orifice. The symptoms present are mostly those of some obstruction at the time of eating. They have mostly occurred, as in Doctor Mathews' cases, in obese women, and people forty years or over. One of these patients had an ulcer. She was put on a dietary régime. She has gone along quite satisfactorily in that way.

He saw one case operated upon where the hernia recurred, but the patient did not know it had recurred and she was perfectly comfortable afterwards. She was very uncomfortable while she knew she had it, but not knowing about it later she had no further symptoms. She had been advised previously that the hernia had been corrected.

In another case it was corrected and the patient's symptoms continued about the same, even though the hernia remained reduced.

It seemed to him that the reduction can be better handled through the peritoneal side since it has a definite sac. The important thing is to be certain to suture together, if

possible, two or three layers of definitely fibrous tissue rather than the peritoneal tissue which is often approximated and which does not hold.

DR. PHILEMON E. TRUESDALE said he believed œsophageal hernia could be dealt with more conveniently or more efficaciously by a transthoracic approach. It seemed to him that it could. He had attempted the operation from below and failed. He had done the operation from above, providing more adequate room for the use of both hands in the pleural cavity by a two-rib or three-rib resection. In this manner one can operate with a considerable degree of facility at or near the œsophageal opening.

Moreover, it seemed to him that in dealing with hernia through the abdominal wall, ordinarily one operates from above toward the peritoneal cavity and not through the peritoneal cavity out into the sac. The same principle might well hold true in dealing with an œsophageal hernia where the sac extends into the pleural cavity.

He had a patient, a woman, aged fifty-one, who came to the clinic for a gastric disturbance. She was anæmic, apparently from loss of blood, which she had noticed in her stools. Her general condition was good, and she appeared to be of a sturdy type. The Roentgen-ray examination revealed a diaphragmatic hernia involving the cardiac end of the stomach. He decided to investigate the stomach from below, and found that she had an ulcer high on the lesser curvature and that the cardiac end of the stomach had herniated through an œsophageal opening. He excised the ulcer by the Balfour method. About three weeks later, through a transthoracic operation, he reduced the stomach from its position in the pleural cavity, and then closed the gap. She is now back at her occupation, after eight months, and appears to be well.

Silk is the suture to use in these cases, because any form of catgut softens and swells. It is elastic and, with the constant motion of the diaphragm, may yield to slight tension.

DOCTOR TRUESDALE further said that Doctor Mathews made the statement that hernia of the diaphragm is no longer a curiosity. He believes this is unquestionably true. Nevertheless, it is still considered so rare that it is liable to be overlooked. When the symptoms are abdominal they are usually mistaken for chronic intestinal obstruction, ulcer of the duodenum, cholecystitis, pancreatitis, or some other lesion of the gastro-intestinal tract. When the thoracic symptoms predominate they are sometimes mistaken for bronchitis, whooping-cough, pneumonia, pleurisy, or heart disease.

# THE PRESENT STATUS OF THE TREATMENT OF TUBERCULOSIS OF THE CERVICAL LYMPH-NODES

By Richard H. Miller, M.D.

of Boston, Mass.

We have had for about twenty-five years, at the Massachusetts General Hospital, a small clinic for the observation and treatment of non-pulmonary tuberculosis, exclusive of orthopedic conditions. It has seemed wise, at this time, to present to this Association a brief statement of our attitude toward tuberculosis of the cervical lymph-nodes, chiefly because our feeling about it has changed in the past half decade. We were brought up to be conservative, not to operate if we could do anything else, and to postpone surgical measures till the last. Time and experience have led us to question the broad application of this policy.

Tuberculosis of the lymphatic system is much less common than it was, even a few years ago; this fact has been strikingly apparent in our clinic, and only last year it was made the subject, by Landis, of a report entitled "The Disappearance of Scrofula."[1] The reasons for it are (1) the elimination of infected cattle, (2) the pasteurization of milk, (3) the widespread extirpation of the pharyngeal and faucial tonsils, and (4) the segregation of adults with active pulmonary disease.

In the first place, to review briefly the anatomy, there is, forming a sort of collar around the base of the skull, a circle of superficial nodes, the occipital, mastoid, pre-auricular or parotid, facial, submaxillary and submental groups, to which are added the tissues of the faucial tonsil and pharyngeal tonsil, or adenoid. These all drain into a group of deeper nodes called the carotid or substernomastoid group, lying under the upper end of the sternomastoid muscle. Of this latter group, the anterior ones drain directly the tonsils, and the posterior ones drain directly the adenoids. These carotid nodes have an efferent vessel, the jugular trunk, which empties into the subclavian vein on the right and the thoracic duct on the left; therefore bacilli which are carried away from these nodes make their way directly into the venous circulation and into the right heart. There are in addition scattered nodes in the posterior triangle of the neck, or that portion behind the sternomastoid muscle, and these nodes are most abundant just above the clavicle, forming a special supraclavicular group. This latter group is said to have an efferent trunk of its own which empties, on either side, into the abovementioned jugular trunk.[2, 3] There must be, however, fine lymph channels which connect the carotid with the supraclavicular nodes, and these account for the spread of infection from the former to the latter. We see not a few cases in which tuberculous infection, apparently getting in through the tonsils, involves only the supraclavicular nodes, or others of the posterior triangle, and it is interesting to speculate on how this infection has hurdled

the first barrier—the fence, as it were, of the carotid group. The bacteria may have taken a circuitous course, going through or around the carotid nodes without stopping.

There arises the very important question of the relation of the infected cervical lymph-nodes to pulmonary tuberculosis. In the first place, as these nodes drain into the jugular trunk, and thence into the venous system, there is no direct path of communication between them and the tracheobronchial nodes, nor is there a direct lymphatic connection between them and the apex of the lung. Much work has been done to elucidate the reason why there is so much tuberculosis of the pulmonary apices, but it is not entirely conclusive. Grabfield and van Zwaluwenberg,[4, 5] and later Grabfield and the author,[6] have worked on the study, by röntgenograms, of the occurrence of involvement of the apical pleura in instances of disease of the cervical nodes. The figures are not conclusive, but we have thought that there was an increase in the thickness of the apical pleura (so-called pleural caps) in these cases. All we can say is that this thickening is suggestively greater in cases of cervical tuberculosis and it would be a simple theory if it could be substantiated.

A careful observation of many cases leads us to the conclusion that in a large number of instances the tuberculous nodes in the neck constitute the primary locus of disease after it has passed the tonsils and adenoids. This statement does not, of course, leave out of consideration earlier instances of infection, but we believe that for the period of infection of which the enlarged nodes are a manifestation, those nodes constitute the primary locus. In other words, in the cases as we see them, the infection is not deposited in the lymph-nodes from the blood-stream, as might result from a pre-existing focus in the lungs, but is carried directly to them from the pharynx. Therefore, these nodes are a primary focus, and a central distributing station from which tubercle bacilli may be carried into the blood-stream and thence around the body. If this is correct, early extirpation of the nodes would be, in certain instances, not only a proper therapeutic but a proper prophylactic measure.

The diagnosis of this type of tuberculosis often presents to us a difficult problem, because so many cases have no symptoms or signs except a swelling in the neck, and there may be nothing to suggest whether we are dealing with tuberculosis, lymphoblastoma, branchial cyst, or any one of many other less common tumors. Although our ability to make a correct diagnosis of tuberculosis improves as our experience becomes greater, a scrutiny of our operative records would reveal examples of the following conditions in which a diagnosis of tuberculosis was incorrectly made—Hodgkin's disease, actinomycosis, branchial tumors, neuro-fibromas, secondary cancer, syphilis, subacute non-tuberculous infection, mixed tumors of the salivary glands, and even perithelioma of the carotid body. In cases in which diagnosis is difficult we always recommend biopsy, feeling that the attainment of a correct diagnosis is far more important than the consideration of the minor cosmetic problem of a small scar in the neck. In patients with active pulmonary tuberculosis the occurrence of enlarged cervical nodes should not, it seems

to me, offer so much of a diagnostic problem, although of course the presence of this disease would not rule out branchial cyst or cancer. In cases of pulmonary disease the bacilli may be brought to the nodes via the blood-stream, or deposited from the sputum on the tonsil, thence making their way into the neck.

In the discussion of treatment, I shall confine myself at first entirely to those cases in which there is no evidence of active pulmonary disease, or active general tuberculous infection. I should accept, however, the thesis that early after the infection of the cervical nodes, there supervenes a low-grade, sub-clinical tuberculous bacillæmia. If we could apply to the human being Krause's work on experimental animals in regard to the length of time it takes a few bacilli to make the circuit of the body through the blood-stream,[7] it would be a short interval indeed from the first infection of the lymph-nodes to the state of bacillæmia.

Since the institution of our clinic we have constantly employed, as a thera-peutic agent, a form of tuberculin—the Bouillon Filtrate or B.F., obtained from the Saranac Lake Laboratory for the study of Tuberculosis. It was originally given to most all cases save those with active pulmonary disease, starting with a dose of 0.0001 milligrams. Injection is given once a week, the dose being increased slowly, and care being taken to avoid undue reaction.

I was at first much impressed by what seemed to me to be the therapeutic value of tuberculin, and in 1922, I published a paper,[8] recommending its use in cases of lymphatic disease. The enthusiastic ideas which I then conceived, and which I thought were supported by figures, gradually dissipated, as I saw many cases, which I thought were cured, come back with further trouble. The report was produced in a moment of too great optimism. Since that time we have, however, continued to use tuberculin in many instances, feeling that in a few cases it might be worth while. We have felt that it was a good thing to keep up our familiarity with it as a clinical method of treat-ment, at the same time discarding any extravagant hopes for unusual, or even usual therapeutic successes.

One aim of the clinic has always been to advise heliotherapy whenever possible, and to this end we constantly give instructions to patients to try to get as much sunlight, consistent with safety, as they can. This is notably difficult in the climate of Boston, where the weather is so unstable, but some patients have been able to employ it to apparent advantage.

Artificial light we use as much as we can, employing both the Carbon arc and ultra-violet lamps. The proper evaluation of the results of this treat-ment is difficult because we have not run a series of cases using this alone, for the reason that it has seemed to us that other things were important and, if they were of avail, we should not deprive the patient of their benefit. To a large measure we have combined the use of artificial light therapy with the use of tuberculin.

The results of a small unselected series of cases, in which both tuberculin and lamp were used, are given in Group I.

## Group I
### *Treatment with Tuberculin and Lamp Therapy*
#### (57 *Cases*)
Improved, 26, 45 per cent; Not improved, 18; Doubtful, 13.

We use no internal medication except cod-liver oil and tomato juice, which we prescribe almost always.

With Röntgen-ray therapy our experience has been too limited to allow us to offer any conclusions of value. The most extensive recent review of the subject was published by Hanford[9] in 1927, and he says: "Small doses of filtered Röntgen-ray given at intervals of less than three weeks appear to shorten the course of the disease and to favor resolution or marked improvement in all stages (except cold abscesses) in a sufficiently large percentage of cases to justify the conclusion that the Röntgen-ray is useful in the treatment of tuberculous glands of the neck."

Hanford notes that the cases most helped are those with tuberculous sinuses, and those with small lymph nodes; and that 40 per cent. of cystic swellings resolved without incision or spontaneous opening. He found that of 141 patients 47.5 per cent. were apparently cured in an average of ten months, and 23.4 per cent. were "so markedly improved when last seen as to make the treatment appear satisfactory." He adds that other methods of treatment, minor and major surgical operations, should be employed when indicated.

In the early days of our use of the X-ray we found our enthusiasm dampened by the case of a young man with very extensive tuberculous nodes on both sides of the neck, in whom a series of treatments with the Röntgen-ray was followed by a rapid subsidence of the nodes and coincidentally an equally rapid miliary tuberculosis and unexpected death. One could not say, to be sure, that the treatments were responsible for the result, but the sequence of events was so striking that it was very difficult to convince one's self that such was not the case.

A series of unselected cases in which various methods of treatment were used, including a few with X-ray, is given in Group II. These cases include minor operations, heliotherapy and other measures.

## Group II
### *Treatment by Various Methods*
#### (110 *Cases*)
Improved, 52, 47 per cent.; Not improved, 21; Doubtful, 19; Partly improved, 10; Recurrences, 8.

We now come to the question of surgical treatment, and here at once we enter on debated ground, a sort of no-man's land. Let me repeat that I refer to cases in which the cervical tuberculosis is the only clinically active focus of disease, particularly those cases in which there is no pulmonary disease.

Incision and drainage are indicated when the node, or nodes, have broken down and the overlying skin is red and the tumor is fluctuant. The drainage,

once instituted, is easy to maintain, because, if the incision is at all adequate, there will be no tendency for the skin edges to adhere to each other. Inasmuch as there is always diseased lymphatic tissue lying underneath the pus cavity, and inasmuch as this tissue must be sooner or later cast off, if not absorbed, curettage is further indicated. Light curettage never does any injury to important structures, and always succeeds in removing a certain amount of tissue which is better out than in. One often hears the query as to whether, after such an operation, the wound should be swabbed out with some antiseptic such as iodine. Our experience leads us to believe that, practically, such a procedure is of no importance, and though it does no harm, it does no good.

The treatment of the large un-inflamed cold abscess may be protean. To dissect out such a sac of pus is really impossible, because there is no cyst-wall—one breaks into the cavity, the pus comes out, and then there is almost nothing left. Evacuation of the contents through a needle and syringe, with injection of certain antiseptic fluids, is strongly advocated by some, but has never appealed to us as a sound procedure. It seems to us that the most satisfactory method of handling this type is to make a small incision, not more than ¼ inch in length open and evacuate the abscess, and then sew in a small rubber tube, which is to be left in place for ten days or two weeks. A sinus is thus established, and it will drain for some time, often for weeks, and then will heal, and, with luck, there will be no remaining diseased tissue.

Among the most frequent of types which one sees are the cases with a tiny sinus, discharging a little pus, off and on, and underlying the sinus is felt a hard, irregular mass—lymph-node tissue which is often cicatricial, calcified, mildly infected, and of varying sizes, usually small. In these instances the gland acts almost as a foreign body, and as such it should be removed.

In our clinic we were brought up to look on the radical excision of cervical tuberculosis as anathema, and a procedure to be reserved only for cases in which no other form of treatment could be of any possible avail. We carried on for years, influenced by this feeling, and deterred from operation by the fear of unsightly scars, nerve injuries, spreading of infection, and recurrences. At the same time, the surgical department of the Children's Hospital, in Boston, and a few eminent surgeons such as Dowd,[10] in New York, continued to insist that excision, in proper cases, remained the method of choice.

Hence, while influenced by this principle of conservatism, we continued to treat the cases in that way, but gradually, uninfluenced by any other investigators, or by any literature, we began to realize that the results of conservatism were very often unsatisfactory, and that after months, or a year or two, we would find ourselves recommending operation as the most suitable way of getting rid of the disease, or at least that part of the disease that was bothersome and unsightly. There grew up in us the feeling that in taking a fresh case of tuberculous cervical nodes, which could be easily extirpated, and embarking on a period of months of treatment, we might be deluding

both the patient and ourselves into a sort of false hope, a hope that, more often than not, failed to be realized. Then I personally saw four cases, in young and otherwise robust people, which progressed from what seemed to be localized disease in the neck to most tragic consequences; two young women, and one young man, under our conservative treatment, developed severe pulmonary or generalized tuberculosis and died, while the fourth, a young woman, is in a State institution with extensive pulmonary disease. So far as we could determine, in these four instances the primary focus of the then active disease was in the neck, and, rightly or wrongly, it seemed to us that early removal of those nodes might have saved the patients.

At just the time when we were crystallizing our ideas in regard to the advantages of surgery, Hanford,[11] of the Presbyterian Hospital, and Clute,[12] of the Lahey Clinic, announced independently the same conclusions. Clute wrote: "For the average patient, who cannot afford the time or expense of prolonged hygienic treatment, surgery seems the method of choice." With this we heartily agree.

Operation will not, of course, be suitable for all cases. It should be reserved for those with fairly discrete masses, preferably rather early in the course of the disease. If there are nodes on both sides of the neck, the operation may be done in two stages. It is never necessary to do the extensive dissections with removal of the sternomastoid muscle as was formerly done, and as is indicated in cancer; and if the incision is made parallel with the natural creases in the neck, the scars will not be too unsightly. The spinal accessory nerve, the most important one which is encountered, can always, with care, be spared. Recurrences do take place, but the fear of this possibility should not make one forego operation. We believe that the operation *per se* does not cause the dissemination of tubercle bacilli throughout the body.

The technical details need not be described here. The removal of an extensive group of enlarged and adherent nodes is not a task, to be sure, for the inexperienced, but in the hands of a careful and well-trained man, it is a procedure more likely to do good than harm.

The results of an unselected series of radical operations is given in Group III. These figures seem at first glance to be hardly any better than those in the other tables, but they do, in our opinion, represent a much more satisfactory group of results than the others.

GROUP III

*Treatment by Radical Excision*
(89 *Cases*)

Improved, 46, 51 per cent.; Recurrences, 23; Doubtful, 16; Other tuberculosis, 4.

When one comes to discuss the treatment of enlarged cervical nodes in a patient with active pulmonary disease or miliary tuberculosis, the question is a different one. We believe that operation should not be performed unless the tumor is causing symptoms, such as pain from pressure of the swelling, or apparent toxic sequelæ, or having a bad mental effect on the

patient. The operation must be done as quickly as possible, and under a carefully selected anæsthesia. Ether is contra-indicated, because it may be instrumental in aggravating a pulmonary process.

In conclusion, I have several points to make: they are not startling, and merely represent the ideas at which we have arrived in a surgical clinic:

(1) Lymphatic tuberculosis in the neck is slowly disappearing as a result of proper elimination of infected cows, proper pasteurization of milk, and the widespread and increasing custom of removing children's tonsils and adenoids. These measures are of untold prophylactic value.

(2) Cervical tuberculosis is, in many instances, a primary focus of disease, a focus from which bacilli may be, and soon are, carried into the general circulation.

(3) Cervical nodes furnish one of the few instances in which the primary focus of tuberculosis can early be seen, felt, and extirpated, without damage to the patient.

(4) We believe that where these nodes are discrete, where the technical difficulties of operation are not insuperable, and where there is no active pulmonary or general disease, radical excision should be given serious consideration as the treatment of choice.

DISCUSSION.—DR. EMMET RIXFORD (San Francisco, California) said that some twenty-five to thirty years ago tuberculosis of the lymph-glands of the neck was extremely common in San Francisco; now it is so rare that there are hardly cases enough to teach students. The cessation of tuberculosis of the glands of the neck in this community was startlingly sudden and coincided with the cleaning up of the milk supply. A distinguished German pathologist had stated that a comparatively small percentage of these cases was due to the bovine type of tuberculosis bacillus. Coincidentally, other forms of surgical tuberculosis, in general, ceased almost as dramatically. And in those cases the bovine type of tuberculosis bacillus rarely is found; it is generally the other.

In the days when California's surgeons had those cases they used to operate upon practically all of them. But it was soon found that it was not necessary to do the radical operation. They took out the major infected glands, knowing that a great number of little ones were left rather than take out the whole lymphatic-bearing area. Those patients did perfectly well. Our experience demonstrated that there was no necessity of being very radical.

The spinal accessory nerve causes much grief. Doctor Rixford was called on one occasion in a hurry to see a child that had been operated on by some other surgeon, but when he got there the child was dead. There had been oozing inside the wound which had not been properly drained. This was in the days when these operations were done in the clinic rather than in the hospital. There were so many of them that there was not enough hospital room. In this case the blood-pressure had choked the baby. Ever since then the operations always have been done under hospital conditions.

DR. MARTIN B. TINKER (Ithaca, New York) recalled the paper which was published by Dr. Charles Dowd as one of the best discussions on the subject ever presented. Doctor Dowd had the lymph-nodes carefully examined by Doctor Park, who found that in those cases over 30 per cent. were caused by the bovine bacillus.

Doctor Dowd brought out one or two valuable points with regard to the technic of the operation. He proposed the hockey-stick incision. It is possible to have the more or less vertical arm of the incision running with the hair-iine so that a young woman can easily cover that part of the scar by dressing her hair. The lower horizontal leg of

the incision can be covered by a string of beads, or at least so it will not be very conspicuous.

In regard to injuring the spinal accessory nerve, it is readily possible to find the spinal accessory nerve by dissecting carefully down the posterior border of the sterno-cleidomastoid muscle; the spinal accessory nerve penetrates the muscle and can easily be found as it comes through the muscle. One can follow it up through the group of glands without injury in practically all instances.

Another point in regard to the technic is the division of the sternocleidomastoid muscle when necessary. It may be done a very little distance above the clavicle, where one avoids all injury to the nerve supply of the muscle. The nerve supply comes from the spinal accessory and cervical plexus and hits the muscle nerve in the middle of the muscle. If one goes below that damage to the nerve supply of the muscle will be divided.

In his own experience he had seen a number of persons die following involvement of the lymphatic glands of the neck in which operation was not done. One was a little boy who had a rather extensive involvement of the glands of the neck. He decided to have an operation because a sister, only a few months previously, had died of tuberculosis spinal meningitis following lymphatic-gland involvement. It is true that a number of cases requiring operation is very rapidly decreasing.

He had noticed, too, that since taking up practice in a relatively small city, where the hygienic conditions are good, there are really few patients of tuberculosis of any kind as compared with the number of cases he used to work with in Philadelphia, or at the Johns Hopkins Hospital.

In certain instances tuberculosis of the glands of the neck will not yield to any form of conservative treatment. The son of a physician came to him a number of years ago who had had everything—the rest cure in the open air, as the patients have at Saranac Lake, X-ray treatments, ultra-violet-ray treatments, and every other conservative method. He had had five operations, and still was not cured. A thorough incision cured that young man and he has now been well for a number of years.

He believed that there are a large number of such cases. He questioned, personally, whether any of the glands that have become definite cases ever cease to be a menace to the patient.

Dr. FRANK S. MATHEWS (New York City) said that at the St. Mary's Hospital for Children in New York the number of new patients per year with cervical-node tuberculosis has dropped from about fifty to less than five in the course of (say) twenty-five years. He was strongly convinced that the disappearance was a question of milk and not of tonsils.

He personally had had several patients who had gone to the country for the summer with the idea of preserving the children's health, and were very careful to pick out one farmer and one cow for milk for the children. He recalled three such cases. In one of those cases three acute cases of throat infection, followed by tubercular glands, arose. I don't need to mention the other two. But that has been sufficient to demonstrate that in those cases it was a question of giving tubercular milk.

He had said that the treatment of tuberculous glands of the neck depended entirely on the specialty of the physician consulted. If he were a tuberculosis specialist, at least a few years ago, he probably would give tuberculin; if it were the general family doctor he would give them hygiene; if an X-ray man he would give them that, even if the glands were calcified; and, finally, there is the general surgeon who might want to make them surgical. But all of these groups will turn them over to the general surgeon if they are doing badly; if they are breaking out and causing sinus trouble, they are all likely to step from under.

He advocated surgical treatment at the very earliest before the condition gets all over the neck and axilla and becomes suppurative.

DOCTOR MILLER, closing the discussion, remarked as to the suggestion of Doctor Tinker that a majority of these cases are due to bovine bacillus, that this has been

true more in England and Scotland where there has not been, up until now, such good control. He believed there that more than 90 per cent. has been due to bovine bacillus.

The effect of X-rays has been very carefully studied by John Hanford, at the Presbyterian Hospital, in New York. He decided, in cases where operation was not feasible, that certain good results could be obtained by the use of the X-ray. They had, however, a tragic case which made them distrustful of it. It was a young man of about twenty with very large nodes; in fact, so extensive that an operation hardly seemed possible. He was given the regular series of X-ray treatments. Coincident with that he developed miliary tuberculosis and died in the course of a few weeks. In that case there was no doubt that the X-ray set loose the tubercle bacilli which invaded the blood-stream in large numbers.

## REFERENCES

[1] Landis: The Disappearance of Scrofula. Am. Rev. Tuberc., vol. xxi, No. 2, p. 195, February, 1930.

[2] Wood: The Nose and Throat in Cervical Adenitis. N. Y. State J. Med., vol xviii, p. 95, 1918.

[3] Wood: The Significance of Tuberculous Deposits in the Tonsils. J.A.M.A., vol. xliv, p. 1425, 1905.

[4] Van Zwaluwenburg, and Grabfield: The Tonsillar Route of Infection in Pulmonary Tuberculosis. Am. Rev. Tuberc., vol. v, No. 1, p. 57, March, 1921.

[5] Van Zwaluwenburg, and Grabfield: Apical Pleuritis and Its Relationship to Pulmonary Tuberculosis. Am. Rev. Tuberc., vol. v, No. 4, p. 323, June, 1921.

[6] Grabfield, and Miller: A Study of the Relationship of Tuberculosis Cervical Adenitis to Pulmonary Tuberculosis. Am. Rev. Tuberc., vol. xxii, No. 6, p. 598, December, 1930.

[7] Krause, and Willis: The Rate of Dissemination of Virulent Tubercle Bacilli in Normal and Immune Guinea-pigs. Tubercle, vol. vi, p. 438, 1925.

[8] Miller: The Treatment of Tuberculosis Cervical Adenitis. J.A.M.A., vol. lxxix, p. 350, 1922.

[9] Hanford: Röntgen-ray Treatment of Tuberculous Cervical Lymph-glands. Arch. Surg., vol. xv, p. 377, 1927.

[10] Dowd: Indications for the Removal of Enlarged Cervical Lymph-nodes. N. Y. State J. Med., vol. xviii, p. 109, 1918.

[11] Hanford: Early Diagnosis and Early Radical Operation in Tuberculous Lymph-glands of the Neck. N. Y. State J. Med., October 1, 1928.

[12] Clute: The Surgical Treatment of Tuberculous Glands of the Neck. ANNALS OF SURGERY, vol. lxxxvi, p. 666, 1927.

# PARACELSUS

## By Fred B. Lund, M.D.

### of Boston, Mass.

In June, 1527, in Basel, Switzerland, the day before the Feast of St. John, which the students of the university were to celebrate by a large bonfire in the public square, the following notice in large letters appeared on the door of the city hall: "The famous Doctor Paracelsus, City Physician, will speak at High Noon tomorrow in the Town Square upon the New and Marvelous Light of Medicine. He will also touch upon the Ignorance, the Avarice and the Strutting Vanity of the Doctors of Basel." Exactly at noon Paracelsus appeared. He was dressed in a sweeping black silk robe trimmed with red. His hat was black and gold. He wore a long sword and carried an ebony staff. Behind him walked a page carrying two large books bound in leather. For a moment he faced the crowd in silence, then strutted up and down the platform, sweeping the flagstones with his robe, showing off his staff, his sword, and his regal stride. Then he stopped, tore off his hat and threw it savagely into the audience, slammed his sword on the pavement, broke his staff over his knee, stripped off his robe, rolled it into a crumpled ball and sent it after his hat. He advanced toward the crowd bareheaded, in a plain gray jacket, sleeves rolled up to the elbows. "Thus," he screamed in his shrill voice, "thus should a doctor appear before his patient—to cure by knowledge, not by fine clothes; by science, not by gold rings and jewels." He motioned to the page who handed him one of the books. With a furious gesture, Paracelsus tore it in two and threw it on the furnace. It blazed up in a burst of yellow flame and black smoke. "That was Galen," he shouted.

The second book followed, and a second burst of flame rose up. "That was Avicenna," shrieked the heretic doctor. "Old bloodless words. Vain mouthings of ignorance. Latin sounds meaning nothing. From these books your doctors get their Latin for diseases they know nothing about and their Greek for diseases they never heard of. Gray-bearded frauds, old wormy moth-eaten sophists, lousy pretenders with their fine clothes, their long steps, their Latin to hide their ignorance. They cling to the rich like leeches and let the poor die like flies. They make a disease out of nothing but a pain in the belly from too much eating. And when there is a real disease, they fly from it afraid for their reputations. Their cures are worse than the illness. They burn the flesh with hot irons, give black draughts which tear at the bowels. Their plasters raise blisters as thick as a hand. Then they go back to their snug studies, thumb over Hippocrates, that old Greek; and Galen, that old Roman, and count the golden coins they've stolen from your pockets."

Who was this man who made this dramatic appearance; what was he, and how, so to speak, did he get that way? Why did Robert Browning, at the age of twenty-two, write a poem about him many pages long, a poem on the general plan of Doctor Faustus, in which this tremendously successful physician, chemist and surgeon, devoted his life to the pursuit of knowledge, only to find out just before his death that he had made the fatal mistake of pursuing knowledge instead of beauty? Why does a book on the Crusaders of Chemistry give him place as one of the great contributors to that science? Why did he found a new school in medicine, the Mineralists, in contrast to the Galenists, so that after his time up to the present date apothecaries have had to be learned in the lore of both schools? Why did Ambroise Paré say that from him he had learned important principles in wound treatment, while the theosophical society publishes a biography of him which would have you to believe that his principal contribution to learning was connected with Astrology, Necromancy and the Black Arts in general? Why did his enemies picture him as a drunken vagabond, a charlatan, who rejected all the learning of the schools for his modern alchemism, mineral caustics and strong acid remedies? The answer to this may be that he had the most caustic and bitter tongue that was ever wielded by a medical controversialist. He showed up the doctors of the old school in their false colors. I have always thought that it was fitting that he should have burned the works of Galen, for Galen's works, too, are copiously interlarded with pages, nay volumes, of bitter and valueless controversial material. When we come to study Paracelsus as the product of the intellectual movements of his time, acting upon one of the most active, tireless, restless intellects that ever lived, we may find a partial answer to some of these questions, but surely a volume or two rather than a forty-minute paper would be required for any adequate answer. Europe, at the time of his birth, was in the throes of two of the greatest intellectual convulsions that have ever shaken the world, the Renaissance and the Reformation. Across the intellectual mirk and chaos of the dark ages, the light of science was beginning to gleam, first through the revival of Greek and Latin learning, which at that time was generally known through the Latin translations from the Arabic, which were in turn from the Syrian translations from the Greek. Considering the nonsense which translations, difficult at best, when made by hired scribes, without medical knowledge, must have made of them, is it any wonder that Roger Bacon had said that the works of Aristotle ought to be burned? A glance at the birth dates in the years surrounding the birth of Paracelsus will be of interest: in 1483 Luther, in 1493 Paracelsus, in 1510 Girolamo Cardano, in 1517 Erasmus and Vesalius. Machiavelli, Leonardo da Vinci, Ariosto, Rafael, Columbus, Copernicus, Thomas More, Arbroise Paré and Michelangelo were contemporaries. In the words of Stoddart: "It was all one birth, new religious expression, new thought, new science, new art. And these were only amongst the many voices of that

great human restlessness which desired what it could not formulate until they came."

Theophrastus Bombastus von Hohenheim was born at Einsiedeln, Switzerland, November 10, 1493, a date easily remembered as being one year after the discovery of America. His father was a physician of good family who married the matron of the pilgrim hospital in Einsiedeln. He was named Theophrastus after the great Greek botanist who followed Aristotle in the Peripatetic School. Bombastus, which one might think from his writings gave the name bombast to boastful writing and speaking, was a family name, formerly Bambast, and did not give the name bombast to the English language, as it has another derivation; von Hohenheim was probably the origin of the latinized name Paracelsus, by which he came to be known, so that the name was not derived from the old Latin encyclopedist, Celsus, with the meaning the second Celsus. He was a small, weak child, difficult to rear; he is said to have had a tendency to rickets. His father kept him in the open air and used to take him for long walks during which he became acquainted with the medicinal herbs in the locality. He said later in his writings: "I have to laugh when I think of the German doctors sending to Italy and across the Mediterranean to the Far East for medicinal plants, when God has given such an abundant supply right at home in Germany. The German doctors are Arabs, Greeks and Chaldeans, who prefer foreign medicines and know nothing about German medicines, prefer medicines from over seas when they have better remedies in the gardens in front of their houses." There is a story that he was castrated when he was a boy by some drunken soldiers who were billeted in his father's house; evidence has been adduced from his portraits in favor of this story. Considering the man's character and work, it is hard to believe. He was brought up in the fear of God and later wrote much on morals and religion. Probably from his father in his early youth he got his love for the study of nature, which later was to lead him so far afield during almost his entire life. Born, as has been said, in the times of the Renaissance and the Reformation, he imbibed from the one his impulses to the light of nature, to scientific induction and comparison, and from the other his religious tolerance. He probably remained always a Catholic, but what he says later about Luther is of great interest. He had been called by some of his enemies, in view of his attempted reforms in medicine, "the medical Luther," and this was his answer—"The enemies of Luther are composed to a great extent of fanatics, knaves, bigots and rogues. Why do you call me a medical Luther? You do not intend to honor me by this, because you despise Luther. I know of no other enemies of Luther than those whose kitchen prospects are interfered with by his reforms. Those whom he causes to suffer in their pockets are his enemies. I leave it to Luther to defend what he says, and I shall be responsible for what I say. Whoever is Luther's enemy deserves my contempt. That which you wish to Luther, you wish also to me, you wish us both to the fire."

In 1502 his father was appointed town physician at Villach in Karinthia. His father taught chemistry or alchemy in a school in Villach which was intended to train overseers and chemists to superintend and instruct the miners in the nearby lead mines at Bleiberg, and to analyze the metals and ores. He had a laboratory in his house. Here were laid the foundations of that knowledge of chemistry of which he made so much use that he was called the founder of the mineral therapy, as distinguished from the old Galenic, or vegetable, therapy.

He studied the occult arts with his father. Without such knowledge it was thought at that time that no one could become a physician, for positive science as such was unknown. In 1510 he was in Basel in a school which may be called perhaps a high school, which was in the hands of the scholiasts and pedants of the time. Disgusted with the barren lore of the schools, he went to Würzburg to gain instruction from the Abbot Trithemius. who had a great reputation for occult research. Trithemius believed in magnetism and telepathy. He was able to read the thoughts of others at a distance. He used a cryptic jargon in which he interpreted portions of the Bible and of cabalistic writings. He insisted upon reverent study of the scriptures, as did his pupil. These studies from Trithemius were probably what lead him to adopt the various cabalistic terms which have made his writings so difficult, nay sometimes impossible, to interpret. He believed in magic, he believed that if a wax image of an enemy were made and buried under stones, the enemy would be covered with bruises even as the wax image was, and that if you hung a picture of a thief who had stolen something on your wall and stuck a sword through it, the thief would be wounded in the same place. But he objected to necromancy and all magic designed to injure others, and never practiced it. He practiced magic only for the benefit of others, and especially for their healing under the direction of God.

He said regarding Alchemy: "Alchemy is to make neither gold nor silver; its use is to make the supreme essences and to direct them against diseases." All the same he did believe one metal could be transformed into another, at least if I read his writings correctly. He always had a laboratory, whenever in his wandering life he ever stayed for any length of time, and worked hard in it. A certain pupil named Oporinus followed him for many years in the hope of learning the secret of producing gold, which he (the pupil) thought he had. He was finally found to be unfaithful and was dismissed.

At the age of about twenty-two he worked in the silver mines and laboratories of the Fugers in Schwatz in the Tyrol. Paracelsus studied the mines and their veins of precious ore and worked hard in the laboratories among the chemists. Many of the analyses belonged to occult experiment, and the influence of the stars was frequently sought, with the observance of days and hours and cryptic measurements and weights. Paracelsus himself soon gave up "gold cooking," as he called it, for the study of the various metals and their salts. In his first book, the Archidoxa, which was

not published until seventy years after his death, he gave some of the results of his chemical investigations, including chapters on "The Mysteries of the Microcosm, The Mysteries of the Fifth Essence, (Quinta Essentia); The Mysteries of Extractions of Specifics; On Renovation and Restoration, *etc.*" He adopted as the elements the water, fire, earth and air of the old philosophy. He was the discoverer of zinc-oxide ointment. In fact, if not the discoverer of zinc, he was the first to use the word in literature. Of zinc and its compounds he gave a very good description. He introduced preparations of iron antimony, mercury and lead into pharmacology. He investigated amalgams of other metals with mercury, the uses of alum, and the gases arising from solutions and calcination. He considered the three basic principles necessary to all bodies to be sulphur, mercury and salt in his cipher terminology—sulphur standing for fire, mercury for water, salt for earth, otherwise for inflammability fluidity and solidity. Air he left out, considering it a product of fire and water. He adopted the platonic theory of the Macrocosmos and Microcosmos by which the body of man became an embodiment in little of the universe, and carried it to such ridiculous length as to give to the wind in the intestines in the various kinds of colic the same names as the winds of heaven, Boreas, Eurus, Auster and Notus. When they got blowing against each other or the wrong way, we had a belly ache.

Other results of his experimental research were the chloride and sulphate of mercury, calomel, flowers of sulphur, and many distillations. He guarded the use of all medicines in later treatises by earnest counsel to physicians to know well the diseases for which they were administered. "For," he said, "every experiment with medicine is like employing a weapon which must be used according to its kind: as a spear to thrust, a club to fell, so also each experiment. And as a club will not thrust and a spear will not fell, neither can a medicine be used otherwise than for its own disease. Therefore it is of the highest importance to know each thoroughly and its powers. To use experimental medicines requires an experienced man who discerns between the thrust and the blow, that is to say who has tried and mastered the nature of each kind.—The Physician must be exactly acquainted with the illness before he can know with what medicine to conquer it. A wood-carver must use many kinds of tools in order to work out his art. So, as the physician's work is also an art, he must be well practised in the means which he employs."

In his book called "The Book of the Three Principles" (Salt, Sulphur and Mercury), he says that, reduced to their lowest terms, there are only three diseases and three remedies, therefore why the endless nonsense about Avicenna, Mesne and Galen. Diseases should be called by the names of their cure, leprosy, gold disease, being cured by gold, and epilepsy, vitriol disease, because it is cured by vitriol.

After ten months' hard work at Schwatz he left Villach on his travels. He decided that his university experience was as barren of results as if he were in a garden where the trees were all stumps, and that he would trans-

plant himself into another garden, where the trees grew tall and bore all manner of fruits. "A doctor must be a traveller," said Paracelsus, "because he must inquire of the world. Experiment is not sufficient. Experience must verify what can be accepted or not accepted. Knowledge is experience."

In spite of his displeasure with universities, he went first to Vienna, then to Cologne, and then to Paris and Montpellier, then to Italy to Bologna, Padua, and Ferrara; then to Spain and Granada, and Lisbon; then to England, where, we are told, he visited Oxford, and also the lead mines in Cumberland and the tin mines in Cornwall. In England he heard of the fighting in the Low Countries. He went there and secured a place as barber surgeon to the Dutch Army. As he had found in the book of nature his authority in scientific research, he made use of the wounded for his study of surgery. "The sick should be the doctor's books," said he, as Hippocrates had said before him. He found in war his opportunity for enlarging his knowledge of wound surgery, as did his successor Ambroise Paré, and we shall see how often he found employment as an army surgeon during his years of travel. Probably during this service he picked up the long sword which was painted in all his later portraits, and in the handle of which he is supposed to have carried a supply of "labdanum," which was probably his term for laudanum.

In 1518 he took service with King Christian of Denmark in his war against the Swedes. He worked among the wounded of both sides. He took note of the methods of treatment practiced by the soldiers, and the medicines administered by the country people to their wounded. Of course he visited the mines in Sweden, as he later did in all the countries where his travels took him. Later he wrote a book on the Diseases of Miners. Then he travelled on horseback through Brandenburg to Prussia; then to Bohemia, Moravia, Lithuania and Poland; then to Wallachia, Transsylvania, Carniola, Croatia, Dalmatia and along the coast to Fiume. He travelled on hired horses, joined trains of merchants on their way to market, travelled with pilgrims, friars, gypsies and vagabonds. His reputation went with him, and he was called to the houses of the wealthy to practice his profession. He collected enough to pay his travelling expenses, which were not much. He picked up all the information he could as he went on from soothsayers, wise women barbers—anybody who practiced cures of any sort.

In the fourth Book of Defences he says:

"The universities do not teach all things, so a doctor must seek out old wives, gypsies, sorcerers, wandering tribes, old robbers, and such outlaws, and take lessons from them. We must seek ourselves, travel through the countries, and experience much, and when we have experienced all sorts of things, we must hold fast that which is good."

Again, in the Fourth Defence he reiterates:

"My travels have developed me: no man becomes a master at home, nor finds his teacher behind the stove. For knowledge is not all locked up, but

is distributed throughout the whole world. It must be sought for and captured wherever it is.

"Sicknesses wander here and there the whole length of the world, and do not remain in one place. If a man wishes to understand them, he must wander too. Does not travel give more understanding than sitting behind the stove? A doctor must be an alchemist. He must therefore see the mother-earth where the minerals grow, and as the mountains won't come to him he must go to the mountains. How can an alchemist get to the working of nature unless he seeks it where the minerals lie? Is it a reproach that I have sought the minerals and found their mind and heart and kept the knowledge of them fast, so as to know how to separate the clean from the ore, to do which I have come through many hardships?

"Why did the Queen of Sheba come from the ends of the earth to hear the wisdom of Solomon? Because wisdom is a gift of God, which He gives in such a manner that men must seek it. It is true that those who do not seek it have more wealth than those who do. The doctors who sit by the stove wear chains and silk, those who travel can barely afford a smock. Those who sit by the stove eat partridges and those who follow after knowledge eat milk-soup. Although they have nothing, they know that as Juvenal says: 'He only travels happily who has nothing.' I think it is to my praise and not to my shame that I have accomplished my travelling at little cost. And I testify that this is true concerning Nature: whoever wishes to know her must tread her books on their feet. Writing is understood by its letters, Nature by land after land, for every land is a book. Such is the Codex Naturæ and so must a man turn over her pages."

From France he took ship for Venice, where he spent some time as army surgeon to the Venetians who were engaged in a war with Charles V. One of their wars was for the defence of the Island of Rhodes against Suleiman II, the Magnificent. He mentions a disease which he found among "Saracens, Turks, Tartars, Germans and Wallachians." Here he made observations on arrow wounds, the bow and arrow being used no longer in western wars.

He then visited the Tartars in the Balkan Peninsula and Southern Russia, and went as far north as Moscow. Here among the herds of cattle he learned about the treatment of horses, cattle, sheep and goats. He journeyed from Moscow to Constantinople with a Tartar prince. He learned from Saracens and Turks the lore of their saints and from Jewish physicians and astrologers the secrets of their dread Kabbala.

From Constantinople he returned to Venice in 1522, and again took service with the Venetians in the war between the Emperor Charles V and Francis I, King of France, for the possession of Naples. Wherever he went he practiced his new medicine and surgery, reviled and abused the physicians of the old school, is said to have successfully treated many patients given up by his colleagues, at least he says he did. He remarks: "I pleased no one except the sick whom I healed."

After his army service he settled in Tübingen to practice as a physician, but soon had to leave on account of the opposition of the regular profession. While he was at Würtemberg he visited a number of mineral springs, including Nieder Baden, now Baden-Baden. Later he wrote a copious treatise on mineral springs, medical baths, *etc.* He tried practice in Freiburg for a while, and then went to Strassburg, where he purchased a citizenship and settled down.

From Strassburg in 1525 he was sent for to come to Basel to attend the famous publisher Johann Froben who had as his guest the distinguished Dutch humanist, Erasmus, who lived there as Froben's guest eight years. Paracelsus cured Froben of an old injury of the foot for which amputation had been suggested. He became a friend of Erasmus and treated him by letter for gout and kidney trouble; two most interesting letters, one from Paracelsus to Erasmus, and the other, his reply, are preserved.

Through the influence of Oecolampadius and Froben, Paracelsus was appointed town physician at Basel, which included a lectureship in Medicine in the University and the superintendence of the town apothecaries. He lectured in German, a grave offence to the old school, and is said to have been the first university lecturer to speak in the vernacular. What was worse, he invited not only medical students, but barbers, bath-men, tradesmen and all the citizens to attend his lectures. He offered his own experience and his own experiments in the place of comments on the Galenic lore. He thought little of the gorgeously attired Basel doctors and praised the simplicity of dress which he noticed among the doctors of Spain. He tried to reform the city apothecaries, who were both careless and extortionate, and made up his own medicines. He used his tincture of opium, which he called labdanum, and his mineral remedies. These circumstances are what led up to the scene described at the beginning of this paper. One can imagine how all these things endeared him to the physicians of Basel. He gave demonstrations as well as lectures. He lectured at Basel on the Degrees and Components of Recipes, on Natural Substances, Diagnosis by the Pulse and Face, Disease Arising out of Acidity, Diseases of the Skin, Open Wounds and Ulcers, Surgical Lectures on Wounds Received in War, on Pharmacy, on Blood-letting, on the Preparation of Medicines, and many other subjects.

"I wish you to learn," he would urge, "so that if your neighbor requires your help, you will know how to give it, not to stop up your nose, like the scribe, the priest, and the Levite, from whom there was no help to be got, but to be like the good Samaritan, who was the man experienced in nature, with whom lay knowledge and help. There is no one from whom greater love is sought than from the doctor."

In a lecture on the doctor's own character, he said:

"1. He shall not consider himself competent to cure in all cases.

"2. He shall study daily and learn experience from others.

"3. He shall treat each case with assured knowledge and shall not desert nor give it up.

"4. He shall at all times be temperate, serious, chaste, living rightly, and not a boaster.

"5. He shall consider the necessity of the sick rather than his own: his art rather than his fee.

"6. He shall take all the precautions which experience and knowledge suggest not to be attacked by illness.

"7. He shall not keep a house of ill fame, nor be an executioner nor be an apostate, nor belong to the priestcraft in any form."

The enmity toward him of the regular profession grew worse and worse. Doctors, apothecaries, barbers and bath-men banded together against him. They called him a "Luther in Medicine," a "liar," a "fool," a "suborner," a "necromancer," and other equally uncomplimentary epithets. He replied as follows: "The doctors take more trouble to screen their movements than to maintain what concerns the sick, and the apothecaries cheat the people with their exorbitant prices and demand a gulden for messes not worth a penny."

He accepted an invitation in Zürich where his students there gave a banquet in the course of which he addressed them as "combibones optimi," and they in return addressed him as "our own Theophrastus." Such apparently was the sole foundation for the charge of habitual drunkenness which was made upon him by his medical colleagues, and was so emphasized and insisted upon that it has lasted to this day.

Troubles accumulated for him in Basel. His friend and patient Frobenius died. He was threatened with assassination. They published a lampoon in excellent Latin entitled: "The Shade of Galen against Theophrastus, or rather Cacophrastus." It purported to be a letter from Galen postmarked "Hades"; a spiteful and scurrilous fabrication it has been called. It was nailed to the door of the cathedral, where all might see it. Stirred to the depths, he made an indignant appeal to the Town Council. He kept quiet in public, but in private invented nicknames for his foes, among the mildest of which were "Doctor Blockhead" for the doctors, and "scullerycooks" for the apothecaries.

He treated at this time a wealthy canon of the cathedral, Leichtenfels by name, who had offered a hundred gulden to any one who should cure him, and only sent for the so-called heretic after the failure of many others. Hohenheim got him over his pain and sleeplessness, but he refused to pay more than six gulden. Hohenheim sued for his fee and lost his case. He was to be outlawed and exiled to an island in Lake Lucerne. His friends warned him, and he fled, never to return to Basel. Here is part of what he wrote afterward about these colleagues who had treated him so basely in the preface to his book "Paramirum": "I am not afraid of them, but I am afraid of the discredit which they will thrust upon me and of the out-of-date Law, Custom, and Order which they calle Jurisprudence."

He went to Alsace and to Colmar, where he visited in the house of Dr. Lorenz Fries, who, though a Galenist, was broadminded enough to be-

friend him, who appreciated his good qualities, and who believed that the teaching at the universities should be carried on in German instead of Latin.

At Colmar, Paracelsus sent for his pupil Oporinus to come from Basel with his luggage, and proceeded to hire a lodging and set up a laboratory in the cellar. He also treated many sick who resorted to him and made friends among the learned men of the better class. The two best friends Paracelsus made in Colmar, Hieronymus Boner and Konrad Wickram, were devout Catholics, and though Paracelsus sympathized in many points with the reformers, he never left the Catholic church. He wrote several books in Colmar, one dedicated to Boner, dealing with French Malady, Paralysis, Boils, Perforations and the like, and also a part of his great work on surgery, the "Chirurgia Magna."

It seems ridiculous to ascribe the sin of habitual drunkenness to a man who worked so hard and wrote so much.

He was now barely thirty-five years of age, but as a result of his hard work, travels and persecution, looked nearer fifty. Oporinus was his secretary and chemical assistant, but was disloyal to him and had really followed him in order to worm out of him the supposed secret of the transmutation of metals into gold.

From Colmar he went to Esslingen in Switzerland. Here also he fitted up a laboratory in a cellar. He did not remain long there. In 1529 he was in St. Gallen, where his friend, Bartholomew Schobinger, a man of intelligence and means, fitted him up a laboratory at Castle Horn. Late in 1529 he travelled through the mountains to Franconia and Nüremburg. He carried with him his "Prognostications" and his completed work on the "French Malady," of which he recognized the contagious quality. He discussed the differences between the primary lesion in the male and female, recognized contagion apart from coitus, and distinguished between syphilitic and what he called surgical lesions by the effectiveness or failure of mercurial treatment.

No book could be published in Nüremburg without passing the Censor (familiar sound). He got these books by the Censor, but while he was in the country at a place called Beratzhausen, waiting for their publication, he got word that no more books by him could be published there. This was due to the fact that the Medical Faculty at Leipzig had taken cognizance of his abuse of their class and requested the Council of Nüremberg to publish no more books by Theophrastus. They naturally did not like being called "imposters." As Stoddart says: "another stroke from 'Galen in Hell.'"

He worked in Beratzhausen for seven or eight months on the Paramirum. Here he travelled for miles to visit an important patient, made his diagnosis, and was proceeding successfully with the treatment when the patient's brother-in-law, a Doctor Bürtzli, broke into his room, stole his medicines, and announced that he would carry on the cure himself. From Beratzhausen he set out on his travels again.

In 1531 he was again at St. Gallen. He lived at the house of the

Burgomaster Christian Studer, who had put himself under his treatment, and continued his work called the "Opus Paramirum." Leaving St. Gallen at the end of 1531, he wandered about for many years. At St. Gallen he completed the four books of the Paramirum. This remarkable book deals with the Five Entia or causes of disease: I. The "Ens Astrale" is the action not so much of the stars as of the climate, the sun and moon, and the weather in general, as influencing the health. II. The "Ens Veneni" diseases coming from the poisons arising from the excreted portions of food and drink. (By the way, we have an "alchemist" in the stomach whose duty is to separate the poisons which are to be excreted from the portions of food which are to be absorbed. If he is not on duty, the "Ens Veneni" gets us.) III. The "Ens Naturale," diseases arising from Nature, including the natural humors, of which there are many more than the four of Hippocrates and Galen. IV. The "Ens Spirituale," diseases which come from the spirits of men. The spirits have hand-to-hand conflicts, so to speak, outside the bodies of their possessors, and the winning spirit can inflict all sort of trouble on the body possessing the loser. "He is a fool who denies the power of the mind over the body," says our author. Last, there is the "Ens Dei," a class of diseases produced by the direct influence of God in his infinite wisdom. A most interesting treatise. In this book, superstition, religious reverence, and occult learning struggle with exact observation, experiment and common sense; now one wins, now the other. All his works that I have attempted repay reading in the original. The old German is not too hard, the periphrastic and picturesque style, and the evident downright earnestness of the man come out much better in the original than in the translation, even if at times one realizes that one does not get all of his meaning.

It seems that the physician must know all about these entia, because a disease which comes from one ens may seem to come from another, and the right treatment can only be given if we recognize the causal ens, for the ens spirituale, something like the Coué treatment or Christian Science, might be the right thing.

Some people think (Stoddart) that Hohenheim had a prevision of the decomposition of light by the prism, but from the passages quoted, that seems to me rather doubtful.

The "Opus Paramirum" closes with a second address to Joachim von Watt, echoing Hohenheim's bitter cry: "Who hath believed my report? Strange, new, amazing, unheard of, they say are my physics, my meteorics, my theory, my practice. And how should I be otherwise than strange to men who have never wandered in the sun? I am not afraid of the Aristotelian crowd, nor of the Ptolemaic, nor that of Avicenna; but I fear the insults ever thrown in my way and the untimely judgment, custom, order, which they call jurisprudence. Unto whom the gift is given he receives it: who is not called I need not call. But may God be with us our Defender and our Shield, to all eternity. Vale."

After finishing the Paramirum, Hohenheim lived for some years in

Switzerland, notably in Appenzel. Here he was busy ministering to the sick poor, in whose spiritual as well as corporeal needs he became so interested that he as well as those to whom he showed hospitality were persecuted by the priests. He was reduced to poverty and in 1534 fled in utter want to Innsbrück, where he returned to the profession of medicine. The burgomaster would not give him permission to practice because of his ragged appearance. He took the road again, this time by the Brenner Pass to Stertzing, where the Plague had broken out. He wrote a book on the Plague, which he had encountered previously in his travels. He made enough from his profession while there to purchase clothes, food and lodging. From there he went to Meran. About this time his father died, but he did not learn of it for four years during which time he was continually travelling. He then went mountaineering and ended up at St. Moritz, where he analyzed the water of the famous spring, an account of whose qualities he published in his book on natural waters.

In September, 1535, he left the monastery of Pfäffers, where he had been visiting and analyzing the waters, and took the mountain road toward Wirtemberg. In 1535 he had finished the most important of his works, "The Greater Surgery." The preface to the first volume follows:

"Concerning The Geater Surgery, the first volume, by the instructed and attested doctor in both medicines, Paracelsus: Of all wounds by stabbing, shooting, burning, biting, bonebreaking, and all that surgery includes, with the cure and understanding of all accidents present or to come, pointed out without errors. Concerning the discoveries of both the old and the new science, nothing omitted.

"Concerning The Greater Surgery, the second volume, by the instructed and attested doctor of both medicines, Paracelsus: Of sores and hurts, their cause and cure, according to proved experience without error and further experiment." In this work there is a most interesting discussion on the suture of wounds. He says any wound, no matter to what tissue, muscle, tendon or blood-vessel, will heal well if left open without sutures and properly protected. If one puts in sutures, the wound becomes inflamed and you have to take them out in a short time, leaving the wound worse than it was before, and you have more than wasted your time and the patient's. "My opponents tell me that the suture of wounds came down to us from the days of antiquity, but I answer them that there were fools in ancient days, just as there are now."

This was published in Augsburg. Before the close of the sixteenth century, nineteen editions of this had been published in German, Dutch, French and Latin. It was from a Latin edition that Ambroise Paré learned Hohenheim's treatment of wounds received in battle. He was detained in Augsburg on matters connected with the publication of his book till 1537. During these years he treated several distinguished patients and became more prosperous, but he was always writing, and wrote among many other books his "Defensionis" and "Labyrinthus Medicorum Errantium." He went

to Vienna, where he was entertained at a banquet in his honor by the City Recorder, Blasius Beham. In Vienna he again incurred the enmity of the physicians to such an extent that no one would receive his manuscripts for publication.

In 1537 he returned to Villach, received the inheritance left him by his father, and accepted a temporary position as metallurgist of the Fuggers. He studied the mineral resources of the Carinthian Mountains and wrote another book about it. Meantime, he had written a book on Stone, Gravel, Chiragra and Pellagra, which he calls the Tartaric Diseases. He tells his patients that if they will follow his treatment. They will avoid "the bloody and uncertain hands of the cutter for stone," This was not published till twenty-two years after his death. He practiced at St. Veit, and there treated the physician to the King of Poland, Albert Basa. His professional foes again bothered him, and once filled the courtyard of the church in order to insult and hustle him as he passed in and out. He travelled for two years longer. Worn out by constant labor and travel, he became ill of some insidious disease; both poisoning and violence were suggested, but not proved.

Sensing the approach of his death he hired a room in an inn in Salzburg and made his will. He left all his medical books, implements and medicines, with the exception of some small money bequests, "to his heirs, the poor, miserable, needy people, those who have neither money nor provision, without favour or disfavour; poverty and want are the only qualifications."

He was buried in the churchyard in the burial place of the poor. He was engaged in religious writings during the last days before his death. Fifty years later his body was removed to a new resting place against the wall of St. Sebastian's Church. This is the inscription on his grave: "Here lies buried Philip Theophrastus, the famous doctor of medicine, who cured wounds, leprosy, gout, dropsy and other incurable maladies of the body with wonderful knowledge, and gave his goods to be divided and distributed to the poor. In the year 1541 on the 24th day of September he exchanged life for death."

Within the forty-eight years of his turbulent life were crowded enough laboratory work, experiment, study, travel, practice and trouble to make a dozen ordinary lives. He loved his God, loved the poor and loved his profession. His superstition, credulity and turbulent spirit were a part of his time. He had much to arouse his just indignation. He believed, however, from the beginning to the end, in observation and experiment and the study of nature and disease as the basis of practice. For these principles he worked, fought and wrote with irrepressible zeal. Many of his contributions to medicine have been mentioned above. He has been called the father of homeopathy, and of many other things. He was surely the first to insist upon the importance of travel and observation in many parts of the world for the equipment of the physician and surgeon. In this sense he may be considered the father of all the societies for medical pilgrimage which have done so much for their members in our time. Many have not yet learned

that lesson from him even up to the present. When we travel in our visits to medical clinics in various parts of the world, let us think of Paracelsus in his ragged cloak, on his hired horse, going from country to country and epidemic to epidemic, studying the book of nature, whose pages are mountains, towns and rivers. We have to go over these pages on our own feet, studying, "with our eyes on the ground like a modest maiden," to use his own words, what is written thereon.

The writer wishes to acknowledge his indebtedness in particular to the writings of Stoddart, Stillman, Sudhoff and the others given in the references which follow. He regrets that the necessary short limits of the paper have prevented a careful estimate of the contributions of our author to Medicine and Chemistry. Perhaps the most judicial account of his life and work is that given by John Maxon Stillman, Professor of Chemistry in Columbia College, New York, in the work cited below.

## REFERENCES

Sudhoff Karl: Theophrastus von Hohenheim, gen. Paracelsus. Sämtliche Werke, Berlin, 1930.

Stoddart, Anna M.: The Life of Paracelsus. Wm. Rider & Sons, London, 1915.

Hartmann, Franz, M.D.: The Life and Doctrines of Paracelsus. The Theosophical Publishing Company, New York, 1910.

Strunz, Franz: Theophrastus Paracelsus: Sein Leben und seine Persönlichkeit, etc. Eugene Diederides, Leipzig, 1903.

Stillman, John Maxon: Paracelsus—His Personality and Influence as Physician, Chemist and Reformer. The Open Court Publishing Co., Chicago, 1920.

Leonard, J. W.: Crusaders of Chemistry. Doubleday, Doran & Co., New York, 1930.

# A CASE OF THYROIDITIS SIMPLEX (REIDEL'S TUMOR)

## BY HERBERT A. BRUCE F.R.C.S., ENG.

### OF TORONTO, CANADA

ONE of the most interesting of the pathologic conditions encountered in the thyroid gland is that type of inflammation described by Reidel in 1896, to which his name is attached. The patients nearly all seek relief from the pressure symptoms produced by the goitre, which, as a rule, begins when relatively small to produce dyspnœa, dysphonia and dysphagia. This is evidently due to the way the hard tumor attaches itself to the structures of the neck. The cause is not known. Shaw and Smith, writing in the British Journal of Surgery in 1925, state that the cases examined were negative for tubercle bacilli, spirochetes and the common forms of bacteria.

The patient was a spinster of forty, who had been employed as a secretary for many years. Her previous health had been good, with the single exception of having had slight menorrhagia. She has pronounced views regarding foods, and eats very little meat. Eleven months previous to admission she noticed an enlargement of her thyroid, about which she worried a great deal, chiefly on account of its appearance. Her basal metabolism was normal. She had a mass of fibroids in her uterus. The thyroid gland was considerably enlarged, nodular, quite hard and mobile. Thyroidectomy was performed under local anæsthesia on November 11, 1926, when three-quarters of both lobes were removed.*

Following the operation there was slight infection of the wound due to the staphylococcus aureus, which was very slow to respond to treatment, but otherwise she made a good recovery, and seven weeks later a sub-total hysterectomy and appendectomy were done, from which a splendid recovery was made.

She enjoyed good health for nearly three years, when she again noticed enlargement of her neck, and felt a constriction about it, especially on lying down. This worried her a great deal and caused loss of sleep and inanition. These symptoms become so aggravated that a secondoperation was advised in July, 1930.

The dissection was very difficult on account of firm adhesions, but two lobes, one 3 by 1½ by 1 inches, the other 1½ by 1 by 1 inch, with a small central portion the size of a filbert were removed, leaving now only the posterior capsule. She made a good recovery, but soon showed signs of thyroid deficiency, which were controlled by small doses of the whole gland.

The pathologist reported that the tissues showed a very diffuse granulomatous type of inflammation, consisting of profilerative changes in the stroma, infiltration of endothelial cells, as well as lymphocytes and plasma-cells. Diagnosis—Reidel's Struma.

Her symptoms have been entirely relieved and she is now in good health.

---

* These were filled with small adenomata.

# THYROID SURGERY AT THE PORTLAND CLINIC

## By Thomas M. Joyce, M.D.

### of Portland, Ore.

We have recently reviewed the histories of patients coming to operation for goitre at the Portland Clinic for the years 1925, 1926 and 1927. This was done to ascertain our results after the lapse of a period of three to six years. During the three years mentioned, approximately 1,500 patients with goitre were registered, of which number 1,066 came to operation. Questionnaires were mailed to all of these patients, but answers were received from less than 700.

Of the 1,066 operative cases there were nine post-operative hospital deaths, a mortality of 0.8 per cent. for all types. There were four deaths in the hospital in patients waiting for operation; three were exophthalmic goitres in uncontrollable crises, the fourth an adenoma complicated by diabetes and general paresis.

It seems impossible in any paper on goitre to avoid the subject of classification. Nearly every one who has had a hundred cases has modified some existing classification or has devised an entirely new one. No doubt all have some merit, but we feel that far too much time has been spent in discussing this or that subdivision. As long as the classification is comprehensive, understandable, and practical, it makes little difference which one is followed. For the purposes of this paper we divide the subject of thyroid disease into its broad headings: (1) Colloid goitre. (2) Hyperplastic or Exophthalmic goitre. (3) The adenomata. (4) Thyroiditis, and (5) Malignancies.

Clinically, the majority of cases fall readily enough into one of these headings; but it must be understood that one occasionally finds a complex gland which may contain elements resembling nearly all the types, and therefore almost defies classification.

Practically all of the surgical cases belong to the adenomatous and the hyperplastic types. We very rarely see the large non-toxic adult colloid goitres which are so common in Switzerland, and we practically never find it necessary to operate upon the pure colloid type. Goitres in this class in the adult quite commonly undergo degenerative changes and become toxic for this reason, but concomitant with the degeneration we find adenoma formation and therefore class them with the nodular forms. The latter group has been arbitrarily divided into the toxic and the non-toxic types. Nodular enlargements, with normal or but slightly elevated basal metabolic rate, removed primarily because of pressure or for cosmetic reasons, comprise the non-toxic variety.

The 1,066 cases may be roughly grouped as follows:

> 444 hyperplastic goitres with 3 deaths, 0.67 per cent. mortality.
> 410 toxic adenomata with 5 deaths, 1.2 per cent. mortality.
> 200 non-toxic adenomata with 0 deaths, 0 per cent. mortality.
> 5 thyroiditis (including 2 abscesses of thyroid) with no deaths.
> 7 carinomata with 1 death, bringing the total of fatalities to 9.

Death in these cases was due chiefly to the heart. Five of the nine fatal cases had auricular fibrillation and three others had dilated and decompensated hearts upon entering the hospital. Cerebral embolism was responsibile for two deaths, one patient dying two hours after operation from this cause, and one as she was leaving the hospital on the eighth postoperative day. The only death from hæmorrhage and shock came two hours following the operation, as the result of the removal of a large substernal carcinomatous goitre. One exophthalmic case, a young woman whose condition was too desperate for lobectomy, died following a ligation.

The average age of those dying of toxic adenomata was fifty-eight and one-half years; the youngest forty-eight and the oldest sixty-seven years of age. These figures substantiate Crile's statement that the mortality in this type of thyroid surgery occurs almost always after the fifth decade.

The age of those dying of the hyperplastic type, in our series, was considerably younger. The average was thirty-seven years; the youngest twenty-one, and the oldest forty-eight.

Of the seven carcinomata of the series, three had symptoms for less than one year prior to consultation. Little could be done to improve the mortality in this type, but four had goitres of from twenty to sixty-five years' duration and the average age at time of examination was fifty-nine years. Had these four had thyroidectomy for their symptomless goitres prior to the age of fifty they might have been saved.

Only two of the seven cases were operable and these are alive and well today, both having had practically total thyroidectomies followed by radium. One inoperable case lived one and one-half years, his life prolonged considerably by the use of radium; one died two and one-half months following a tracheotomy for obstruction by the growth; two others died within four months after the use of radium; and we have lost track of the remaining case.

The mortality rate is roughly proportional to the duration of symptoms prior to operation. In the adenomata but one death occurred with enlargement of less than ten years' duration, and four deaths in the cases of from ten to fifty-two years' standing. In the hyperplastic type there were no deaths in cases with symptoms of less than one year. Two of the fatalities occurred in old recurrent goitres, one with symptoms for five, and the other for eight years.

The average duration of the disease prior to operation, for hyperplastic goitres, was fourteen months, for the adenomata, twelve years. As time

goes on, this interval is steadily shortening. Without doubt, this is an important factor in our rapidly decreasing mortality rate. The case of shortest duration was only six weeks from the onset of symptoms to operation for a full-blown exophthalmic goitre, while the case of longest duration was an adenomatous goitre of mild toxicity in a woman sixty-seven years of age, which had been present fifty-two years, ever since puberty.

In addition to the nine operative deaths and four hospital deaths already mentioned, we have heard that twenty-eight of the patients surviving the operation have subsequently died of other causes, bringing the total deaths to forty-one. Thus, three to six years after thyroidectomy, we know that 3.5 per cent. of those who underwent operation are dead. This figure possibly should be larger, as undoubtedly there are some deaths in the 300 cases from whom we have received no answer.

The average age of the patients in this series was forty and one-half years, women being a few years younger than men and the hyperplastic type a few years younger than the adenomata. The youngest patient operated upon in this series was fourteen and the oldest seventy-four.

From replies to our questionnaires we find that 80 per cent. of the patients who survived the operation are well and strong and able to work. Three and five-tenths per cent. are dead, and 16.5 per cent. are in fair health only, being incapacitated more or less from various causes, many of which are not referable to their goitre operation. These results are, in our opinion, as good if not better than in most fields of surgery. The average loss of weight prior to operation was twenty pounds, and the average gain subsequently was twenty-five pounds. These figures are of considerable significance as an indication of loss and gain in strength.

Recurrences are found in certain definite percentages in the practice of every thyroid surgeon. We have re-operated cases coming from nearly every part of the country, and no doubt others have done secondary operations on our cases. In this series, secondary operations were performed in 4.5 per cent. of the cases, one case being operated upon three times by us. Of the cases in which we performed the first operation, secondary operation was done in only 1.5 per cent. However, 2.5 per cent. have reported recurrences, and more may develop in the future. Undoubtedly others are among those who did not answer our questionnaire. The incidence of recurrent goitres coming to operation was 3.6 per cent. for the adenomata and 5.7 per cent. for hyperplastics.

The most common symptoms which persist following thyroidectomy are rapid and irregular heart action; in 30 per cent. of the cases these symptoms continued for three months or more; in 15 per cent. some trouble is present to date, three to six years post-operatively.

Mild hypothyroidism was definitely present in 2 per cent. of the cases at the time of the questionnaire. It is very common following resections on the hyperplastic type for two to five months, but as a rule in six months enough gland has regenerated to overcome the lack of thyroid secretion.

In our experience, unless a temporary hypothyroidism results post-operatively, a recurrence is likely later on.

Five minims of iodine daily are given post-operatively to the hyperplastic type for from one month to six weeks. Regeneration of thyroid tissue is delayed or prevented to a certain degree by this means.

To secure ideal results in the hyperplastic type, as much gland should be removed as possible without injuring the parathyroids or the recurrent laryngeal nerves.

One nerve was injured in four cases of the present series. In spite of our most careful efforts, this unfortunate accident will happen at rare intervals. The surgeon is invariably warned by a change in the respiratory note when this accident occurs, and should proceed with the greatest of caution on the other side. In recurrent goitres, in large substernal or retrotracheal goitres, and in rare cases of unusual position of the nerve, injury is most apt to occur. We have seen a dissection of the recurrent nerves by Doctor Foster, of the University of Oregon Medical School, in which the course was directly superior and internal to the lateral lobes. In such a case trauma to the nerves could scarcely be avoided.

Where but one nerve is injured no permanent damage results, as the remaining cord eventually acts as efficiently as both, though a hoarse or husky voice may be present for some time. If both are injured a bilateral adductor paralysis of the cords eventually results, and they assume a constant position of adduction, leaving insufficient breathing space. This may occur as early as six weeks or as late as six months post-operatively. An intense dyspnœa follows which must be relieved by a permanent tracheotomy. Though many measures, such as cordectomy, laryngeal fissure, resuture of the nerves, *etc.* have been attempted, they are rarely sufficiently successful to warrant their trial. Permanent tracheotomy seems to be the only effective treatment.

Exophthalmus was found to be present in 42 per cent. of the hyperplastic cases. Post-operatively, when present, this symptom disappeared on an average in six months in 75 per cent. of the cases, and persisted in 25 per cent. to some extent to date.

Only three cases in this series had symptoms of tetany of sufficient severity to require medication. Tetany may be divided for convenience into acute and chronic varieties. The acute type comes on within twenty-four hours after the operation, with symptoms of numbness and tingling in the tongue, fingers and toes, carpo-pedal spasm, and even generalized epileptiform convulsions. The blood calcium drops below normal and the Chvostek and Trousseau signs become positive. These cases are controlled by parathormone intravenously, massive doses of calcium lactate by mouth, calcium chloride intravenously, cod-liver oil with Viosterol and sunshine. Within a week or ten days the œdema and swelling, which have rendered the circulation to the parathyroids insufficient, will have subsided, and the patient recovers.

The acute type may pass into the chronic, if parathyroids have actually been removed, or if the circulation is permanently impaired. Regeneration of parathyroid tissue has not been observed. Chronic tetany may also appear several weeks or months post-operatively without previous symptoms, probably due to scar tissue contractures interfering with the blood supply to the parathyroids. These cases often have periodic convulsions quite similar to those of epilepsy. Several such cases have come to our office with that diagnosis. The history of a thyroid operation, the blood-calcium estimation, the Chvostek and Trousseau signs, make the diagnosis. Viosterol calcium lactate and non-protein diet will often carry these patients along comfortably. Occasionally one of severe grade will require more vigorous medication.

Auricular fibrillation and myocardial degeneration are the real causes of thyroid mortality today. These conditions do not appear for a long time after the onset of symptoms, and are most commonly found in old degenerating adenomata, though they may develop as the result of old neglected hyperplastic glands as well. In this series there were fifty-three cases of fibrillation with five deaths, nine per cent. mortality. All of these deaths were preventable. Earlier diagnosis and treatment would have saved every case. The only unavoidable deaths in the entire series were the two cerebral emboli and the fatality following removal of the substernal carcinoma.

A certain number of the deaths from malignancy may be prevented by the prophylactic removal of adenomata prior to the cancer age. Pemberton[1] has reported that 87 per cent. of carcinomata of the thyroid develop from preëxisting adenomata.

Thus, when the laity are educated to earlier consultation, earlier operation, prior to the development of cardiac failure or malignant degeneration, may be performed. This will reduce the deaths in a series such as this fro mnine to three, the mortality rate from o.8 per cent. to but o.2 per cent. As time passes we are steadily approaching this ideal figure.

## REFERENCES

[1] Pemberton, J. deJ., Report of Surgery of the Thyroid Gland and Spleen for 1930. Proc. of the Staff Meet. of the Mayo Clinic, vol. vi, p. 151; March 11, 1931.

# THE END-RESULTS OF THYROIDECTOMY

By Frederick A. Coller, M.D. and Eugene B. Potter, M.D.

of Ann Arbor, Mich.

Goitre has undoubtedly been the subject of more careful study by surgeons during the past decade than any other lesion, with the happy result that, due to a wider knowledge of the disease, better selection of cases, meticulous pre- and post-operative care, refinement of operative technic, the mortality from surgical treatment in the hands of the experienced has fallen to its ultimate low level and the complications formerly so formidable have largely disappeared. The occasional death after thyroidectomy is commonly due to the neglected disease, rarely to an accident in the treatment. Until etiology of the disease is known, any betterment in our therapeutic results will come from many critical studies of the end-results of surgical and other forms of treatment. Some such studies have been made, but when one considers the vast volume of the literature on goitre, one is struck by the relatively small amount of attention given to this important phase of the subject.

In order to check up our results in the University Hospital with the view to determining the efficacy of surgical treatment for goitre in general and to find our errors in particular, an attempt has been made during the past year to get in touch with the patients with goitre of all types treated by operation during the four-and-a-half-year period from August 1, 1925, to December 31, 1929. An effort has always been made to keep in touch with these patients at least four times during the first year after operation with a considerable degree of success, but after that we tend to lose touch with them as time lapses. The conditions were not ideal for the study as our patients often live at long distances, they are often financially unable to return for re-study and they are frequently lost track of because of changes of residence. Questionnaires were mailed to them which they were asked to fill out, also they were urged to return for examination. When this was impossible, we arranged for many of them to be examined by their family physicians. Practically all patients with residual symptoms and all who were unrelieved were reëxamined by a physician. Basal metabolic studies were made whenever possible either in the clinic or by some other laboratory situated near their homes and were secured on a large number. We were able to get personal or fairly satisfactory check-ups on only 733 patients of about 1,200 treated during this period, consequently we do not have the value of reports on a consecutive series of patients. We are aware of the inadequacy of any method of study of end-results short of frequent, complete examinations with laboratory studies of all patients treated, but in spite of its shortcomings, we feel that this study is of some value in evaluating the degree of rehabilitation in these patients. The opinion of the

patient in regard to the results of treatment must be of some value and we have endeavored in all interviews to get frank, uninfluenced opinions from the patient in regard to the subjective symptoms they have had since operation, whether they were due to residue of the disease or the operation. Eighteen months has elapsed since the last operation and nearly five years since the first one was done on these patients, thus a fair perspective is obtained on the results.

No one can deny the immediate, remarkable change brought about by removal of the major portion of the thyroid from patients with hyperthyroidism; the ultimate results are still under question. It is these late results of the disease rather than complications due entirely to operation that we wish to discuss.

For convenience of discussion the cases are divided into three groups: Those of exophthalmic goitre, adenoma with hyperthyroidism, and adeno-

| | NUMBER | MALE | FEMALE | AVE. AGE | AVE. DURAT. SYMPT. | AVE. DURAT. GOITER | COMPL. REHABILATION | UN RELIEVED | WORSE | IODINE RESIST. |
|---|---|---|---|---|---|---|---|---|---|---|
| EXOPH. GOITER | 267 | 37% | 63% | 37.6 | 14.8 MO. | 9 MO. | 91.4% | 8.3% | 0.3% | 15% |
| TOXIC ADENOMA | 273 | 16% | 84% | 45.9 | 43.7 MO. | 15.6 YR. | 95.6% | 4.4% | 0 | 6% |
| NON-TOXIC ADENOMA | 184 | 18% | 82% | 33.0 | 41.5 MO. | 16 YR. | 94.5% | 3.8% | 1.7% | |

TABLE I. DATA ON THREE GROUPS STUDIED

matous goitre without hyperthyroidism. Whether exophthalmic goitre and toxic adenoma are the same disease or different clinical entities is not pertinent to this discussion; since we make a distinction in our clincal classification in the hospital records, it is simpler to consider them separately.

The technic of thyroidectomy used in all of our patients is one in which all of both upper poles is removed and a resection of the body of the lobes is carried out in such a manner as to leave an expanse of the lateral and posterior aspects of the lobes made as thin as possible. It is impossible to express the amount of thyroid left in a mathematical ratio as this varies with the type and size of the goitre being removed. But as little is left as can be made to cover the lateral aspect of the trachea, the laryngeal nerves and the parathyroids. Muscles are seldom cross-cut but are split longitudinally in the median line and retracted laterally. Fractional operations of two subtotal lobectomies, were performed on thirty-four patients in this series and are, we believe, valuable procedures in those patients who are iodine-resistant or who have serious forms of the disease.

*Exophthalmic Goitre.*—Two hundred and sixty-seven patients with

exophthalmic goitre were studied. They were an average group of patients, the general facts concerning whom are shown in Table I. The ratio of males to females is roughly 1 to 2, average age 37.6 years and the average duration of symptoms 14.6 months. The average gain in weight was 27.6 pounds at the time of reëxamination over the weight at the time of their arrival in the hospital. Excluding patients with recurrences, six patients lost an average of eight pounds while fifteen had no change in weight. Most patients make an astonishing gain in weight during the first few months



| 267 | 91.4% | 8.3% | 0.3% | 273 | 95.6% | 4.4% | 0% |

EXOPHTHALMIC  GOITER              TOXIC ADENOMA

☐ NO. OF CASES
▨ COMPLETE REHABILITATION
▤ UNRELIEVED
■ WORSE
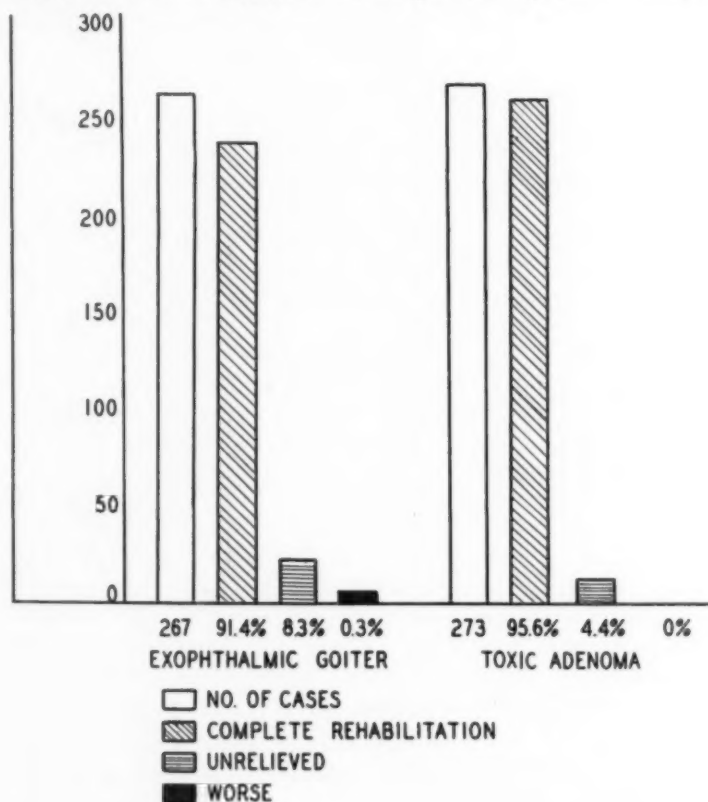
TABLE 2.  GRAPHICAL REPRESENTATION OF REHABILITATION
IN PATIENTS WITH HYPERTHYROIDSM

after operation, often so much as to be objectionable, but during the following year, usually without conscious alteration in diet, they attain their normal weight. A large part of the weight gain is due to lowered basal metabolic rate but some of it is due to a continuation of the appetite and eating habits acquired during their period of hyperthyroidism. The acquisition of obesity plays no part in the restoration to normal and after normal weight is restored it is wise to see that they are on a diet that meets simply their caloric needs.

In estimating the end-results of thyroidectomy, we feel it was not enough to consider only the basal metabolism and to call a patient cured if this was

within normal limits since many patients with a normal metabolism have residual symptoms. We endeavored first to determine the results in terms of the rehabilitation shown in Table II. It was found that 244 or 91.5 per cent. were carrying on the same duties or others equally strenuous as before the onset of the disease. They were not under medical care and were pleased with the result of the operation. Some of them, as will be shown, had residual symptoms that did not materially interfere with the even tenor of their lives. Twenty-two or 8.2 per cent. were unchanged by the operation or were relieved for a time with a subsequent return of symptoms and include all patients that were found to have elevated basal metabolic rates. One or .3 per cent. was made worse.

EXOPHTHALMIC GOITER
267 CASES

| COMPLETE REHABILITATION | UNRELIEVED | WORSE | NO RESIDUAL SYMPTOMS |
|---|---|---|---|
| 244 | 22 | 1 | 129 |

129 (48.3%) HAD NO RESIDUAL SYMPTOMS

115 (43.0%) HAD RESIDUAL SYMPTOMS AS FOLLOWS:

25 (9.3%) EXOPHTHALMOS ALONE

21 (7.8%) EXOPHTHALMOS AND CARDIAC SYMPTOMS ⎫

50 (19.0%) SUBJECTIVE CARDIAC SYMPT. ⎰ TACHYCARDIA ⎱ ⎬ 26.8%
                             ARRYTHMIA
                             PALPITATION ⎭

19 (7.1%) VOICE DIFFICULTY (NOT LARYNGEAL PARALYSIS)

5 (1.9%) RECURRENCE-COMPL. RELIEF WITH 2ND OPERATION

8 (2.9%) RECURRENCE-UNRELIEVED

13 (4.8%) TOTAL RECURRENCE

TABLE 3. DATA ON GROUP OF PATIENTS WITH EXOPHTHALMIC GOITER

A more careful analysis of the group shown in Tables III and IV with complete rehabilitation reveals 129 or 48.3 per cent. of the total to be absolutely free from any symptom or sign of the disease. Basal metabolic determinations were not carried out on many of these patients as the other evidence seemed conclusive. In 115 or 43 per cent. of all patients there remained some residual symptoms that did not interfere with their lives but that were not present before the onset of the disease or the operation.

Basal metabolic studies were made on most of these patients and were within normal limits; in the cases where this could not be done, clinical evidence, such as weight gain and pulse rate, was accepted as evidence of the absence of hyperthyroidism.

Exophthalmos of some degree persisted in forty-six or 17.1 per cent. of the cases. In six patients it remained unchanged and in two patients it actually increased with every other finding normal. Aside from these eight in-

stances the exophthalmos, while still present, was very much less marked than before operation; in many cases hardly noticeable. Persistent exophthalmos was most common in patients in whom the disease was of long standing. The disappearance of a marked exophthalmos was usually rapid to the point of a slight exophthalmos after which the complete return of the eye and ocular muscles to normal took several months. Operative treatment, early in the course of the disease, offers the best chance of obviating the appearance of exophthalmos and also the best chance of returning the eyes to normal after this sign is present.

A voice difficulty was the only complaint in nineteen or 7.1 per cent. The larynx is carefully examined before and after operation and there was

CASES - 267

COMP. REHABILITATION

UNRELIEVED

WORSE

NO RESIDUAL SYMP.

RESIDUAL SYMPTOMS

EXOPH. ALONE

EXOPH. AND CARD. SYMP.

SUBJ. CARD. SYMP.

VOICE DIFFICULTY

TOTAL RECURRENCE
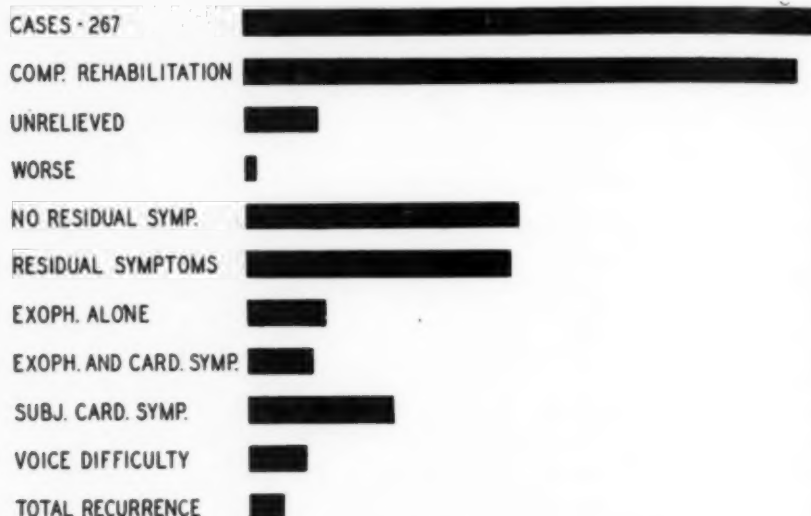
TABLE 4. GRAPHICAL REPRESENTATION OF RESULTS
AND MORBIDITY IN EXOPHTHALMIC GOITER

post-operative unilateral laryngeal palsy present in two patients both of which cleared up in three months, therefore the voice symptoms were not due to nerve injuries. The complaints are of a mild functional type, such as: "Voice more easily fatigued with use," "singing voice not as good," "voice not as strong," "a sense of pressure in the neck with prolonged use of voice." Some of these complaints are undoubtedly functional or neurotic in origin but there must be an anatomical basis for many of them. The extrinsic muscles of the larynx may be the site of scar tissue or may be more or less fixed by scar probably accounting for these mild vocal difficulties which are not of particular importance except to point out the necessity of preserving muscles as well as nerves if one wishes to avoid all symptoms of this type.

The commonest residual group of symptoms was referable to the cardiovascular system. Seventy-one patients or 26.8 per cent. complained of sub-

jective cardiac symptoms, palpitation, arrhythmia or tachycardia alone or in combination, as being present at some time during conditions of stress, excitement or fatigue but not present under ordinary conditions of life. At the time of reëxamination the average resting pulse was 74. The only irregularities of rhythm found were occasional extrasystoles in some of the patients while from the history we felt that a small number had had attacks of paroxysmal tachycardia. There is no doubt but that the heart does not completely return to normal in many cases after passing through many months of this disease but it is remarkable that it is restored to a point where the individual can carry on his life as usual and suffer these minor difficulties only under conditions of bodily and mental stress and strain after weeks and months of the intoxication of hyperthyroidism. Œdema of the ankles was said to be present after operation for some months in forty-five or 17 per cent. but true œdema was not found in any patient in this group at the time of the examination.

Muscle weakness and ease of fatigue was a minor complaint in this group and was present to some degree in twenty-four patients or 9 per cent. It was expressed in some such term as: "Tire more easily than before although able to carry on work." Nervousness is hard to evaluate but no objective signs of it were present in these patients. Thirty-five patients or 15 per cent. complained of nervousness under trying conditions but admitted that there was no comparison between the nervousness that was present before operation and that present now. Many of them stated that nervousness had disappeared gradually over the course of several years to become eventually absent.

To summarize this group of patients who were completely rehabilitated but who had residual symptoms: Those having mild persistent eye signs and minor vocal difficulties are without other evidence of disease and, aside from these historic landmarks, are as well as the patients without any residual symptoms. Those with occasional subjective cardiac symptoms are troubled only during periods of unusual stress and are able to live an ordinary life in comfort. The basal metabolic rates of this group are normal or they have no clinical evidence of hyperthyroidism.

*Unrelieved.*—Twenty-two patients or 8.2 per cent. of patients with exophthalmic goitre in this group were unrelieved by operation according to their own opinion or according to our findings. Eight of them had frank recurrences of the disease with elevation of the basal metabolism. The others presented a diverse group of complaints in the face of normal metabolic rates. Six of them were incapacitated by cardiac disease, four with persistent auricular fibrillation, one with cardiac decompensation, and another with mitral stenosis had had a thigh amputation because of embolism. All of them had large gains in weight but the poor result was due to permanent heart damage. Another group of four complained of severe fatigue and weakness severe enough to incapacitate. Their metabolism was in the low limits of normal and they had better than an average gain in weight. One

has marked uterine prolapse and another large fibroids that may play a part in producing symptoms. Two women were in the menopause and had nervousness that probably was due to this rather than the residue of the disease. Two patients had complaints of chilliness and mental dullness with basal metabolic rates of −15 and −14, while no gross symptoms of myxœdema were present, they both felt better when taking thyroid, therefore they were classed as hypothyroid.

More than half of the patients who were unrelieved had had their metabolic rates returned to normal by the operation but were unrelieved because of permanent heart disease or by totally unassociated lesions that may have been aggravated by the disease or at least associated with it in their minds.

The one patient who was made worse has permanent tetany subsequent to the operation. Two other patients in the entire group had transient tetany that disappeared within two weeks. No positive signs of it were found on any other patients either in the hospital or during the reëxamination.

*Recurrence.*—There were thirteen or 4.8 per cent. recurrences in the entire group. Five of them had second operations in the period under consideration and are now completely relieved with one exception, that of a woman who now has a second recurrence. The other eight still have the recurrent disease or have had the second operation too recently to evaluate fairly. The recurrences fall into two definite classes. Nine of them, who had recurrence within six months, had had the disease in a severe form with a large goitre. The operation was not adequate and one may say that the disease was not arrested and rather than a recurrence one must regard it as a continuation of the disease. The others were really recurrences after an adequate operation that restored the patient to normal only to have a return of the goitre and the disease after the lapse of several years. Recurrences of this type were found always in people who, because of social conditions, were driven to return to hard work a few weeks after operation. The time elapsing between operation and recurrence varied from one to five years. An example in point is the woman of thirty-eight who in 1926 had her original operation with complete relief. The disease returned in 1928 when a second operation was done with again complete relief. She had a recurrence again in 1931. She is the mother of a large family and is obliged to support the family by her own efforts which mean long hours of drudgery with great mental worry. We have operated upon a woman who had been operated upon nineteen years ago and who had a recurrence after this length of time. From our observations we feel that the so-called recurrences due to leaving too much thyroid gland, which is most likely to happen in those patients with large glands and with a severe form of the disease, must be regarded as a failure of the operation to halt the disease and are a continuation of the disease rather than a recurrence. True recurrences in which the disease returns after a restoration to normal by operation are often found to have, as an exciting cause, overwork, worry, anxiety or infections.

The amount of thyroid tissue left behind is hard to describe or measure and is a matter of judgment of the operator. We perform what we consider a conservative operation in contradistinction to the radical operation that leaves but a tiny morsel of thyroid tissue. Recurrence in small percentages is a far better complication than tetany or myxœdema, one easier to treat and one that carries a lower morbidity. From our observations on the entire group of patients with exophthalmic goitre we are struck by the fact that, in general, the speed of the return to normal and the completeness of this restoration is importantly influenced by the duration of the disease and the ability of the patient to have freedom from social cares for some time after operation. We can improve our results by an attempt to control the post-operative course of the patient by utilization of social-service organizations as far as possible for patients who have the burden of family care or support.

### EXOPHTHALMIC GOITER

| | |
|---|---|
| ALL CASES | 14.8 MONTHS |
| NO RESIDUAL SYMPTOMS | 9.0 MONTHS |
| WITH RESIDUAL SYMPTOMS | 14.0 MONTHS |
| UNRELIEVED | 16.5 MONTHS |

### TOXIC ADENOMAS

| | |
|---|---|
| ALL CASES | 43.7 MONTHS |
| NO RESIDUAL SYMPTOMS | 32.3 MONTHS |
| WITH RESIDUAL SYMPTOMS | 32.7 MONTHS |
| UNRELIEVED | 57.0 MONTHS |

TABLE 5. RELATION OF RESULTS TO DURATION OF DISEASE

In Table V are shown the average duration of symptoms of hyperthy-roidism in both the exophthalmic goitre and toxic adenoma groups in rela-tion to the results as already discussed. The influence of the duration of the disease on end-results in exophthalmic goitre is striking. In the patients without residual symptoms the duration is nine months, in the rehabilitated but with some residual symptoms it is fourteen months, and in those unre-lieved it is 16.5 months. This is an important generalization but it is not always true in particular. The above figures are averages, but in the groups with residual symptoms and those unrelieved, one finds patients who have had the disease for only a short time, many less than three months and con-versely, some patients with perfect results had the disease a fairly long time. The second factor of too early an assumption of strain seemed to play a part in prolonging the convalescence of these patients who came for treatment early in the disease.

575

Fifteen per cent. of these patients were iodine-resistant which was due in many instances to the prolonged use of iodine in an attempt to cure the disease before they are subjected to surgical treatment. The use of iodine in the hope of cure has also prolonged the duration of the disease before operation in many instances, increasing the operative risk and leaving the patient with residual symptoms, the presence of which might have been prevented by earlier surgical treatment.

*Adenomatous Goitre with Hyperthyroidism.*—As seen in Table I this group were on the average nearly a decade older than the patients with exophthalmic goitre. The disease occurred far more frequently in women, the ratio of males to females being 1 to 5. Goitre had been present in an average of 15.6 years while the symptoms had been present for much larger periods than in the exophthalmic goitre group, on an average of 43.7 months.

## TOXIC ADENOMAS
## 273 CASES

| COMPLETE REHABILITATION | UNRELIEVED | WORSE | NO RESIDUAL SYMPTOMS |
|---|---|---|---|
| 263 | 10 | 0 | 32 |

132    (48.3%)    HAD NO RESIDUAL SYMPTOMS

131      GOOD RESULTS HAD RESIDUAL SYMPTOMS AS FOLLOWS:

     4    (1.4%)    EXOPHTHALMOS ALONE

     7    (2.5%)    EXOPHTHALMOS AND CARDIAC SYMPTOMS ⎫

                                         ⎡TACHYCARDIA

   86 (31.9%)    SUBJECTIVE CARDIAC SYMPT. ⎨ARRYTHMIA ⎬ 34.4%

                                         ⎣PALPITATION ⎭

     6    (2.1%)    SLIGHT ENLARGEMENT OF NECK WITHOUT TOXICITY

   28 (10.4%)    VOICE DIFFICULTY (NOT LARYNGEAL PARALYSIS)

### TABLE 6. DATA ON PATIENTS WITH TOXIC ADENOMAS

The longer duration of symptoms before seeking surgical treatment is due to the insidious onset and the milder character of the symptoms. The average gain in weight after operation is 24.6 pounds. On reëxamination two remained with weight unchanged and five had lost an average of four pounds.

As shown in Tables VI and VII the total number, 273, all except ten were able to return to their usual life. Of those rehabilitated, 132 or 48.3 per cent. of the total were free from every symptom. The remainder of the group, 131 in number, had mild residual symptoms from the disease or operation. Eleven of them showed very slight eye signs which were not of any real consequence. True exophthalmos was a very uncommon finding in any of these patients, even prior to operation.

A greater number, 10.4 per cent., complained of minor voice difficulties without evidence of nerve paralysis. The larger number than in the exophthalmic goitre group may be due to the fact that the adenomatous goitre

is usually larger and more often distorts the neck structure with a tendency to leave more scar tissue in the neck.

The number with mild residual cardiac symptoms is greater, 34.4 per cent. showing a greater tendency of the adenomatous goitre to leave the heart in an abnormal state. This may be due to the much longer duration of the disease or of the goitre, or the older age of the patients. The symptoms are not constant but palpitation, arrhythmia, tachycardia occur in this group under conditions of strain as discussed previously. Their occasional presence is a departure from the normal but does not prevent them from living in comfort. Whether it will shorten their lives remains to be seen. Their presence is not an indictment of surgical treatment but points out the



TABLE 7. GRAPHICAL REPRESENTATION OF RESULTS
AND MORBIDITY IN TOXIC ADENOMAS

importance of much earlier operation in this group even before frank symptoms of toxicity supervene.

In six patients there was a recurrence of the goitre, all of them in patients under thirty, but without a recurrence of the toxicity.

The ten patients who were unrelieved were largely patients on whom operation had been done too late. Six of them have severe cardiovascular lesions, four auricular fibrillation with cardiac decompensation, one had a hemiplegia, and one has hypertension with anginal attacks. Of the remainder, one has pulmonary tuberculosis but is free from symptoms of hyperthyroidism, another complains of pain in the neck with a sense of pressure in spite of the fact that no evidence of recurrence can be made out. One is insane and one complains of digestive symptoms that he ascribes to his operation. The basal metabolic rates of all of this group were normal. The results of operative treatment in this group are excellent but would be very much better if the patients could be operated upon very much earlier in the course of the disease, preferably when the goitre is noticed in adult life.

*Adenomatous Goitre without Hyperthyroidism.*—Thyroidectomy is done on this group for cosmetic reasons, as a prophylactic measure and for pressure symptoms. A study of the end-results suggests that they are also relieved of many mild symptoms that may be due to an altered thyroid secretion. The average age of these patients was thirty-three years while the goitre had been present for sixteen years. This group is essentially the same as the adenomatous goitre with hyperthyroidism except it is a decade younger with, on an average, a much larger goitre. Hyperthyroidism would probably have developed in many of them if the goitre had not been removed. Ninety-four and five tenths per cent. of them were well pleased with the results of thyroidectomy, in fact many of them were so enthusiastic that we took special care to see why they felt so. About half of them had pressure symptoms due to the presence of a tumor in the neck. Palpitation and dyspnœa were present in over 80 per cent. often ascribable to pressure but present many times when no distortion of the trachea existed. Nearly every patient complained of nervousness of some more or less vague subjective type, such as apprehension, irritability and mental tension. A weight loss was present in more than half the cases while muscle weakness and vague digestive symptoms were present in many. These symptoms did not incapacitate but they were at least uncomfortable and a distinct departure from the normal. In other words, we found evidence that goitre with normal basal metabolic rates were associated with many definite symptoms. Most of these symptoms disappeared after thyroidectomy as shown by the high percentage who were symptom-free after the operation. An argument has been advanced against operation for this type of goitre with a normal basal metabolic rate that there will be produced myxœdema if the goitre is removed, since part at least of the function must be coming from the goitre. A comparison was made of the basal metabolic rates of these patients before operation and a varying period in years after operation and we found them to be essentially the same. A special study[1] was made of seventy patients whose basal metabolic rate was in the lower limits of normal, and the check determination showed 54 per cent. to have a lowered rate of an average 4.6 points while 46 per cent. showed an average gain of 6.7 per cent.—points which enable one to prophesy that the basal metabolism after thyroidectomy for adenomatous goitre with a normal metabolism will remain essentially the same.

Myxœdema was encountered in only one instance in a patient on whom an operation for a recurrence followed a lobectomy done years previously. No patient was found to have true myxœdema associated with a goitre. These observations demonstrate the ability of almost any amount of thyroid or goiterous tissue to maintain a normal metabolic rate. Oftentimes, in removing the degenerating adenomatous goitre, it is impossible to leave anything except abnormal adenomatous tissue which is perforce left as a cover for the parathyroids and the nerves, but even this scanty amount of abnormal tissue is adequate to maintain a normal metabolic function.

In this group there were four recurrences, all occurring in individuals under twenty-five on whom thyroidectomy had been performed for pressure symptoms.

There was an average gain of fifteen pounds in weight. Eleven patients lost on an average of 3.2 pounds and ten patients remained unchanged.

Voice difficulties were noted in 8.7 per cent. Of these, there were seven with paralysis of one recurrent laryngeal nerve, five of which were present before operation and two followed the operation. The much smaller number, complaining of voice difficulties without nerve injuries, leads one to think that some of the complaints of this character in patients who had had hyperthyroidism are on a psychic basis.

Those unrelieved by operation were two with hysteria, one with questionable myxœdema already mentioned, and three who complained of a constant tired feeling with muscle weakness with basal metabolic rates in the low limits of normal. One patient had paroxysmal tachycardia that was unrelieved by operation.

Two were worse following operation, one because of laryngeal palsy and another with persistent auricular fibrillation.

The excellent results in this group emphasized the fact that goitre, with normal metabolic rate, may cause symptoms that are relieved by thyroidectomy and also that the freedom from residual symptoms after operation makes it important to urge removal of the goitre before hyperthyroidism supervenes.

We were interested to note the attitude of the insurance companies toward patients who had had a thyroidectomy. In the exophthalmic goitre group thirty-three had been granted insurance and twelve had been refused. In the patients with adenomatous goitre with hyperthyroidism, twenty had been granted insurance and eleven were refused and in the group with adenomatous goitre without hyperthyroidism twenty-four had been insured and two refused.

*Comment.*—Subtotal thyroidectomy has an immediate brilliant effect on the course of exophthalmic goitre. After a period of years nearly 90 per cent. of them are found to be carrying on their lives in much the same fashion as before the onset of the disease. Less than half of them have some residual effects of the disease or operation that are an inconvenience, but whose presence keep one from saying that they are perfectly free from any evidence of the disease. The fact that the basal metabolism is restored to normal does not mean that the patient is free from residual evidence of the disease. If one includes the patients with only slight persistent eye signs and minor voice changes which are of no marked detriment to the patient, 65 per cent. are found to be physically able to stand any strain. The remainder have cardiac symptoms under conditions of stress that must be regarded as after-effects of the disease. Those unrelieved by operation fall into three groups: one a group in which not enough thyroid tissue is removed, allowing the disease to continue; another group who have true

recurrences after a period of normal health. These are due to the action of an exciting cause, most commonly overwork and worry. A third group who have normal metabolic rates are those who were ill-chosen for operation or who come for operation too late and who were incapacitated by permanent damage to vital organs. There is, in general, a ratio between the results of operation and the duration of the disease. Quite as important is careful post-operative supervision with insistence on a period of rest. Operation should be an incident in the medical care of the disease which should be carried on for a long period of time after operation. Operation may not be a cure but it enables most of the patients to return to work within a comparatively short space of time and prevents the development of permanent visceral damage. The poor results are due to refraining from operation rather than actually operating. - It is unfortunate that a mathematically accurate amount of thyroid cannot be left by the surgeon since even though the thyroid has a great compensatory power the line between producing myxœdema and failure to check hyperthyroidism is a fine one. - Too much harsh comment has been passed on recurrence which is the least harmful of the complications of errors in judgment as to the amount of thyroid left. A second operation in an occasional case is preferable to myxœdema or tetany with the inevitable cataracts in many cases.

In the patients with adenomatous goitre with hyperthyroidism, the results can be improved appreciably if the patients will come to operation earlier in the disease. The higher incidence of slight residual subjective cardiac symptoms is due to the longer course of the disease and the older age of the patient. It is probable that thyroidectomy, at some time in the fifteen years that the goitre is present before symptoms of hyperthyroidism appears, will prevent most of the symptoms referable to hyperthyroidism.

Thyroidectomy for adenomatous goitres with normal basal metabolic rates gives a high percentage of good results. Aside from pressure symptoms there appear to be many mild symptoms that are relieved by thyroidectomy. After the removal of goitre of this type the basal metabolic rates will not change importantly and there need be no fear of producing myxœdema.

At some future time a specific treatment for exophthalmic goitre may be discovered; until that time operative treatment offers a low mortality and high percentage of rehabilitation. For other goitres that are of long standing, surgical treatment offers prophylaxis from hyperthyroidism and other complications and a high degree of rehabilitation after the complication of hyperthyroidism has occurred. Procrastination in carrying out operative treatment, frequently bears the responsibility for the residual symptoms.

### CONCLUSIONS

(1) Subtotal thyroidectomy for exophthalmic goitre gives rehabilitation in over 90 per cent. of the cases.

(2) Of all cases treated by operation about 65 per cent. had no important

residual symptoms and 26 per cent. had mild residual symptoms that did not incapacitate.

(3) The restoration to a normal basal metabolic rate does not preclude the presence of residual symptoms.

(4) Those unrelieved by operation are either recurrences or patients on whom there has been great delay in adopting surgical treatment, or patients poorly selected for operation.

(5) Toxic adenoma show 95 per cent. rehabilitation but 35 per cent. of subjective cardiac symptoms.

(6) There is a definite ratio between the end-results and the duration of the disease, also between the end-results and the character of the post-operative convalescence.

(7) Operative treatment of non-toxic adenoma shows 95 per cent. good results by causing the disappearance of many symptoms as well as removing the tumor causing pressure symptoms.

(8) The basal metabolic rate following removal of non-toxic goitre will be essentially what it was prior to operation.

## REFERENCE

[1] Coller, F. A., and Arn, R. D.: Thyroidectomy for Goitre without Hyperthyroidism. Trans. Am. Assn. for Study of Goitre, 1931.

# PROGRESSIVE EXOPHTHALMOS FOLLOWING THYROIDEC-TOMY; ITS PATHOLOGY AND TREATMENT

By Howard C. Naffziger, M.D.

of San Francisco, Cal.

from the department of surgery of the university of california

THE exophthalmos which is characteristic of a certain type of goitre usually subsides following operative treatment of the gland; ordinarily it is not a matter of any great concern to the surgeon, nor does it require special treatment. In occasional instances, however, this protrusion of the eyes may not subside after operation and may then constitute a disturbing residual symptom of the disease. In still other instances exophthalmos after thyroidectomy becomes progressive and the literature is filled with instances in which this has occurred. Among the reports of particular interest are those of Zimmerman,[1] Burch,[2] and Roeder and Killins.[3] This condition has resulted, in extreme instances, in total blindness. Enucleation of the eye is often necessary because the protrusion advances to such a degree that the lids are no longer able to cover the cornea, and desiccation, abrasion and ulceration with infection result from exposure. Some of these patients show choking of the discs and atrophy of the optic nerves, though this is by no means an invariable accompaniment of the exophthalmos. Ophthalmologists have recommended various procedures for protection of the eye, such as suturing the lid and canthotomy. In other instances, operations upon the cervical sympathetics or the stellate ganglion have been tried upon the theory that the principal factor in the production of the exophthalmos is an over-activity of the sympathetic nervous system, producing its effect upon the involuntary muscles in the orbit. The operations upon the lid, as might be expected, have met with no success, and have had no effect upon the progress of the protrusion. Sympathetic operations likewise, while resulting in a slightly narrowed lid slit and a smaller pupil, have been quite inadequate and unsatisfactory.

An inquiry into the cause of the exophthalmos associated with hyperplastic goitre indicates that there is no concurrence of opinion as to the underlying mechanism. There have been numerous proponents of the idea that certain muscles supplied by the sympathetic nervous system have become over-active and, in one way or another, are responsible, not only for the exoph-thalmos, but for the wide lid slit and the lagging of the upper lid in following downward movements of the eyeball. The muscles of Müller,[4,5] Landström,[6] and Krauss,[7] all have been considered to play their rôles; the muscles of Müller and Landström by acting directly upon the globe, and the muscles of Krauss by constricting the ophthalmic vein so as to produce a venous engorgement, which secondarily has been responsible for the prominence of

the eye. Other explanations offered are that there is an increase of orbital fat or that there has been an œdema of the orbital fat, the reasons for which have not been made clear. Some writers have suggested that venous congestion in the orbital veins is the factor.

A recent experience has shown what has proved to be a satisfactory treatment for progressive exophthalmos and has revealed the pathologic changes which produced it.

CASE REPORT.—An unmarried, white woman, forty-seven years of age, was admitted to the University of California Hospital March 12, 1930, because of progressive exophthalmos and failing vision following thyroidectomy for exophthalmic goitre. Her past history was essentially negative until April, 1928; from April to July, 1928, she gained twenty-nine pounds. During July she became aware of some dyspnœa but medical examination was negative. She was given thyroid-ovarian-pituitary medication for two weeks and lost nineteen pounds. She was then well until November, 1928, when she had transient œdema of the ankles, noted in the mornings, and nocturia; examination at that time was said to reveal no evidence of cardiorenal disorder. At that time she again was given some thyroid-ovarian-pituitary therapy. She improved and remained fairly well for two months, at which time she noted some subconjunctival œdema and slight lacrimation; the urinary findings were normal. In January, 1929, her eyes had a somewhat staring appearance. There was neither history nor evidence of any infection in any part of the body. By the end of February, 1929, her eyes began to be prominent, and, with this symptom, the first evidence of tumor over the thyroid appeared. Shortly after this, she began to lose weight again, became nervous and developed a tremor, with moderate sweating. Palpitation on exertion was present. Her basal metabolic rate at this time was reported to be, on one occasion, 17-plus, and on another 23-plus. In May, 1929, she consulted a surgeon, who advised and performed thyroidectomy. Except for a moderate exophthalmos which was present at that time, there was no complaint referable to her eyes and her vision was normal. Upon leaving the hospital, she was considerably underweight but her nervousness was less and she was able to return to work in two months. Shortly after this, she noticed that her eyes were becoming still more prominent, and the upper lids became œdematous. In August, 1929, three months after operation and seven months before consulting us, she noted that her vision became blurred, and she was told by a physician whom she consulted that her optic discs were choked. At this time her basal metabolic rate was found to be minus-32. From this time on she received one-half grain of thyroid three times a day. Her vision slowly failed. In September she still was able to get around alone, and to write letters, but, by the last of October, she could not see well enough to do either of these.

Upon admission to the University Hospital, she presented an extreme exophthalmos. She was unable to close the lids completely; upon closure the lid margins remained about 2 millimetres apart. Both eyes were about equally prominent. Both upper and lower lids were puffy, the conjunctival sclera was œdematous and watery in appearance, the vessels of the sclera were somewhat injected and the movements of the eyes were limited in all directions, so that the range of movement was reduced to perhaps 25 per cent. of the normal; in addition, the patient was almost blind. She was unable, at a distance of six feet, to recognize anyone and could make out only the outline of a person standing at her bedside. The optic discs were slightly elevated and blurred at the margins, a considerable degree of atrophy had occurred, and minute hæmorrhages were present in the left retina close to the disc.

At that time it was felt that this patient might be suffering from an intracranial lesion, possibly a tumor, which was not only contributing to the exophthalmos, but was responsible for the changes in her optic discs, and the primary investigation was

directed toward determining the presence or absence of such a lesion. Her neurologic examination proved to be entirely negative and encephalograms confirmed the opinion that there was no gross abnormality in her nervous system; her spinal fluid pressure was normal. Measurements with an exophthalmometer read 34 on the right side and 32 on the left side.

It was decided that the protrusion of the eyes could not be explained on the basis of any intracranial lesion and there was no evidence of intraorbital tumor or arterio-venous aneurism. In view of the fact that the loss of vision was progressive and the exophthalmos still increasing, it was felt that a decompression of the orbit offered both an opportunity at once to relieve the exophthalmos and perhaps to determine its cause. A satisfactory explanation of the changes in the optic discs could not be made in the light of our present knowledge, but it was felt that they must be associated with whatever pathologic condition was producing the exophthalmos.

*Operation.*—April 7, 1930 a right frontal operation was performed. The dura was elevated from the orbital plate, which was then opened. The orbital roof was ronguered away widely to give a maximum decompression of the orbital content. The bone was removed mesially as far as the ethmoid and sphenoid cells, and anteriorly as far as the frontal sinus. Laterally the entire plate was removed, and posteriorly, it was removed to the greater wing of the sphenoid. The orbital content bulged markedly through this opening and obviously was under extreme tension. The orbital fascia was opened and the orbital content was exposed. Fat was visible toward the mesial and lateral sides of the orbit, but, upon palpation, it was evident that it was not under tension as contrasted with the tension within the cone of extra-ocular muscles which passed forward from their origin about the optic foramen to the globe. Upon palpation, the tension of this muscle cone was extreme. We felt that the explanation for the exophthalmos must lie here and decided to open through the muscle and to explore the retrobulbar space for the cause of the pressure. Small sutures were introduced into the levator superioris to act as retractors and the muscle fibres were split longitudinally. As the incision was continuously deepened, it was found that, instead of dealing with the normal muscle, perhaps 1½ millimetres in thickness, we were in a deep muscle mass, and the incision had to be deepened to about 1½ centimetres. This muscle was greatly increased in size, was perhaps a little paler than normal, and was distinctly fibrous. This splitting of the muscle was continued forward to the sclera, and its margins were retracted. We were then able to explore the retrobulbar space and the optic nerve as it entered the sclera. No veins and no fat were found within this space. The entire space was filled by this bulk of extra-ocular muscles. Small portions of the muscle were removed for microscopic examination.

With these findings before us, the explanation for the protrusion of the eye was clear. It was caused by an increase in muscle volume. The reason for the changes in the optic discs was not so easily seen. It was considered as a possibility that some constriction about the optic foramen by this same mass of muscle might be a factor in the disc changes. For that reason, it was decided to continue the decompression of the orbit to include the optic foramen and, with this in mind, the bony roof of the optic foramen was ronguered away. The muscle incision was then continued back to the point of origin of the muscle at Zinn's ligament—the fibroperiosteal ring about the optic foramen from which these muscles take their origin. The muscle splitting was continued back to include their origin and the optic nerve was exposed. The muscle became progressively more fibrous and even gritty to the knife and additional portions were removed from microscopic examination. Following the complete decompression of the orbital contents and the optic nerve, the dura of the frontal lobe was allowed to come down upon the orbital contents, the bone flap was replaced and the wound was closed. It was obvious at once, upon the conclusion of the operation, that the right eye had receded markedly. The following day there was considerable œdema of the

lid, which interfered with our judgment of the degree of protrusion. When the recession of the eye was at the greatest the measurements by the exophthalmometer registered 23, as contrasted with 32 prior to operation. During convalescence the right eye became slightly more prominent than it was on the day following operation, but at no time did it reach the previous degree of protrusion. The range of movements of the eye gradually increased; this was true for movements of the globe in all directions, and offered a marked contrast to the still limited movements in the left eye. At the end of one week after operation, it was obvious that the vision was returning rapidly in the right eye. Whereas, prior to operation, the vision was worse on the right, it had now become much better than on the left. In a short time the patient was able to read the addresses on letters, which represented an enormous increase in vision over her pre-operative state. The scleral œdema on the right side also decreased. The patient left the hospital in excellent condition, much pleased with the result.

She returned one month later, insisting that the same procedure be performed on the opposite side. This was done on May 28, 1930, and the patient was discharged two weeks later. At this second operation a procedure was performed identical to that on the right side, and with identical pathologic findings. Portions of the muscle were removed, and the optic foramen and orbital content decompressed. In addition, specimens from the left temporal muscle and from the thigh muscles were removed for the sake of comparison.

Microscopic examination of the extra-ocular muscles on both sides was identical and showed round-cell infiltration, marked œdema, destruction of the muscle fibres, complete loss of muscle architecture with increase in fibroblasts and generalized fibrosis. The temporal muscles and the thigh muscles were normal.

The general course following this second operation was identical with that of the first. There was immediate and marked recession of the left eye; later, a little more protrusion, which, however, did not nearly reach the pre-operative state. A gradual improvement in movements of the globe in all directions followed, with recession of the changes in the optic disc and improvement of vision. The patient has been seen at frequent intervals since that time, and the improvement in her appearance has been most striking. Apparently gradual recession of the eyes is occurring even at this time. She has regained excellent vision. In spite of the large orbital decompression on both sides, there is no lack of parallelism of the eyes and both move well in all directions. There is no diplopia. The œdema and congestion of the sclera have subsided and the lids are becoming less puffy. The optic discs, of course, show some degree of atrophy.

In explanation of the pathologic condition found, that is, the great volume increase in the extra-ocular muscles, pathologic examination would indicate that this is not a true hypertrophy, but rather that there was muscle swelling from œdema and that fibrosis followed. The factors which might serve to initiate this condition are most interesting to speculate upon. A search of the literature has revealed that a hypertrophy, or at least an increase in the volume of the extra-ocular muscles, has been found in other conditions than that of exophthalmos caused by thyroid disease. In these reports one is impressed by the frequency of general circulatory disorders and the possibility of some secondary circulatory disturbance in the orbital circulation. It is well recognized that in certain of the general diseases, particularly in nephritis and in mitral stenosis, exophthalmos is not infrequently seen. Mac-Callum and Cornell,[8] in experimental work, were unable to produce marked exophthalmos in dogs, but produced some slight degree of exophthalmos through stimulation of the sympathetic nervous system and increased it

slightly by tying the external jugular veins. Dr. Margarete Kunde,[9] of the Department of Physiology of the University of Chicago, has reported, in her experimental work upon rabbits, that exophthalmos could be produced if a thyroidectomy were performed upon three-weeks-old rabbits, if these rabbits were later fed with thyroid. No examination of the orbital contents has been reported in these animals. This we hope to present to you at a later time from our own and her experimental work. It is noteworthy that most of the patients who are described in the literature as suffering from progressive exophthalmos have had a normal or low basal metabolic rate as is the case in Doctor Kunde's experimental animals. The patient now reported had a low metabolic rate and had been given thyroid. Also it was noted that an unusually broad collar incision had been made at the time of her operation, and that both external jugulars had been tied. In view of the fact that the venous return from the orbit has a double channel to the systemic circulation, one by an intracranial route, and the other through communicating veins to the facial vein, this might be one factor in the production of the protrusion. The changes Brooks[10] reported in the presence of marked obstruction of venous return flow from muscles in the extremities were similar to those found in this case of progressive exophthalmos.

It is hoped that experimental work now under way may throw additional light upon the mechanism of these muscle changes and also add a link to our understanding of the circulatory changes seen in choking of the optic discs.

## REFERENCES

[1] Zimmerman, Leo M.: Exophthalmos following Operation for the Relief of Hyperthyroidism. Am. Jr. Med. Sci., n.s., vol. clxxviii, pp. 92–99, July, 1929.

[2] Burch, Frank E.: The Exophthalmos of Graves' Disease. Minnesota Med., vol. xii, pp. 668–675, November, 1929.

[3] Roeder, C. A., and Killins, W. A.: A Third Type of Toxic Thyroidism. Northwest Med., vol. xxix, pp. 395–404, September, 1930.

[4] Müller, H.: Relative to the Smooth Muscle in the Ocular Orbit of Human Beings and Mammals. Zeits. f. Wiss. Zool., vol. ix, p. 541, 1858.

[5] Müller, H.: Concerning Smooth Muscles in the Eyelids of Man and Mammals. Phys. Med. Gesell. Verhand., vol. ix, pp. 244–245, 1859.

[6] Landström, John: Basedow's Disease; Surgical and Anatomical Study. Nord. Med. Arkiv., vol. xl, pp. 1–196, 1907.

[7] Krauss: Ueber die Anatomie der glatten Muskulatur der Orbita und der Lider, speziell die Membrana orbitalis musculosa. Münch. Med. Wchnschr., vol. lviii, No. 2, pp. 1993–1994, 1911.

[8] MacCallum, W. G., and Cornell, W. B.: Mechanism of Exophthalmos. Tr. Ass. Am. Phys., vol. xix, pp. 56–63, 1904.

[9] Kunde, Margarete M.: Studies on Metabolism; Experimental Hyperthyroidism. Am. J. Physiol., vol. lxxxii, pp. 195–215, September, 1927.

[10] Brooks, Barney: Pathologic Changes in Muscle as a Result of Disturbances of Circulation; an Experimental Study of Volkmann's Ischemic Paralysis. Arch. Surg., vol. v, pp. 188–216, July, 1922.

# ELECTRO-SURGERY WITH SPECIAL REFERENCE TO GOITRE AND MALIGNANCY

## By Martin B. Tinker, M.D.

OF ITHACA, NEW YORK

This paper is presented because of my conviction that the value of electro-surgery is not as widely appreciated as its advantages merit. Its slow acceptance is from several causes: Electro-surgical apparatus is still in the developmental stage and many surgeons are doubtless unfortunate in buying an outfit imperfectly adapted for their work; the current frequently is not well regulated or suited to the purpose it is desired to accomplish. There is often lack of persistence in developing methods of work and finding satisfactory apparatus. (I tried three before I found one that gave good results.) Those accustomed to use a scalpel which requires pressure at first find difficulty in only directing the cutting point, but recent psychological studies[1] have shown that it is possible to acquire new skill with but little more time and effort in advanced than in earlier life if we have the will.

As concerns malignancy, goitres may be divided clinically into three groups: Those evidently malignant before operation; those not apparently malignant before removal but found to be so by pathologic examination after operation; those showing no evidence of malignancy either by study previous to operation or by pathologic examination after operation but which metastasize, resulting in the death of the patient, the metastases having the gross and microscopic appearance of benign growths. Cohnheim[1] described an apparently benign metastasizing colloid goitre fifty-five years ago, in which there was metastasis to the spine and femur, lungs and lymph-glands. He also mentioned a still earlier case reported by Runge[2] with metastasis to the atlas and axis in which the pathologic examination was made by Von Recklinghausen. Ewing[3] gives reference to eight writers who have reported similar cases. He states that in some instances the goitre is benign, but the metastatic growth malignant; in some cases the goitre is malignant but metastasis is apparently benign; in still others both goitre and metastasis are benign. Delannoy and Dhalluin[4] report a case and give a review of the literature with reports of seventy-one cases up to November, 1921, especially complete as concerns French sources. It is evident that all goitres, however harmless in appearance, are potentially malignant and their management in such way as to avoid metastasis, so far as possible, is in the best interest of the patient.

A highly important advantage of electro-surgery is the prevention of metastasis by sealing blood-vessels and lymphatics. When open in a wound they offer a most likely source of trouble and the frequent late occurrence

of metastasis strongly suggests that malignancy is commonly spread at the time of the operation.

The type of current used determines the effect produced: The rapid-cutting current seals only capillaries and small vessels; *per primam* healing may follow its use even in the skin, while with gland or muscle the healing is apparently as good as with the knife; microscopic section shows only a slight layer of surface coagulation. Slow-cutting current is more effective in arresting hæmorrhage but causes more tissue destruction. The coagulating current causes almost instantaneous clotting for a considerable distance along vessels, while slow coagulation may be used to cook and destroy a considerable area. A non-absorbable surface is formed and superficial cells are killed at the same time that cutting of tissue and sealing of vessels occurs. The non-absorbing surface and coagulated vessels not only prevent metastasis but also prevent thyroid crisis by avoiding absorbing thyroxin
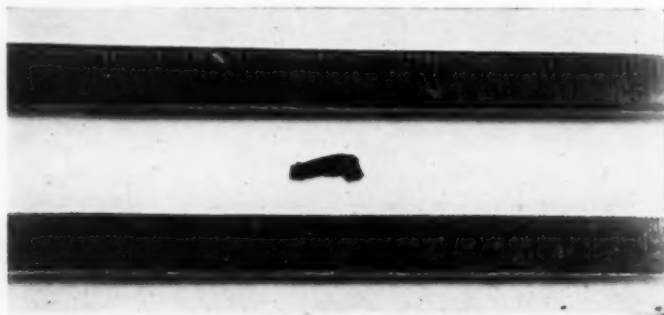


FIG. 1.—Shows the size of vessel which can be coagulated safely in some cases, also length of clot in centimetres and inches.

from the wound. The killing of superficial cells avoids local implantation of cancer cells and also minimizes the risk of infection. The question was raised by Crowell[5] whether these advantages are real or theoretical. That electro-coagulation actually does seal vessels is apparent to anyone with much experience in using it. If a blood-vessel be isolated, clamped and touched with the coagulating current, a clot forms instantly which usually can be seen by all at the operating table and which if desired can be made to extend for one-half an inch or more along the vessel. To show this I had such a section of blood-vessel photographed between two scales, metric on one side and inches on the other. (Fig. 1.) In this instance the clot is well over one-half inch, or fully 12½ millimetres in length. Such a clot could be dislodged but this would not occur with the pressure ordinarily found in the blood-vessels, even if abnormally high, nor would it be likely to be dislodged by ordinary manipulation. The non-absorbing surface produced by electric-cutting current is shown by histologic section of the cut surface on which can clearly be seen a microscopically thin layer of coagulated tissue. (Figs. 2 and 3.) The advantages of electro-surgery in many operations of surgery, not alone in goitre and malignancy, I have emphasized in

previous papers[6, 7] but seem important enough to deserve mention again. The saving of time by coagulating small and medium-sized vessels instead of tying them is great, especially in extensive operations where many ligatures are ordinarily used. The saving of blood from oozing in dealing with tissues having free capillary blood supply is also evident, and this too is specially important in certain goitre operations and in operations where it is necessary to cut across vascular or malignant tissue. Avoiding leaving foreign material, such as catgut or silk, in the wound is conducive to rapid healing as is also the destruction of bacteria by electricity. Prevention of oozing gives better healing by avoiding filling the wound with blood serum, which all experienced surgeons know is prone to occur in goitre surgery even with most careful hemostasis.

Experimental work since publication of previous papers demonstrates what has been claimed by certain writers without laboratory proof, that
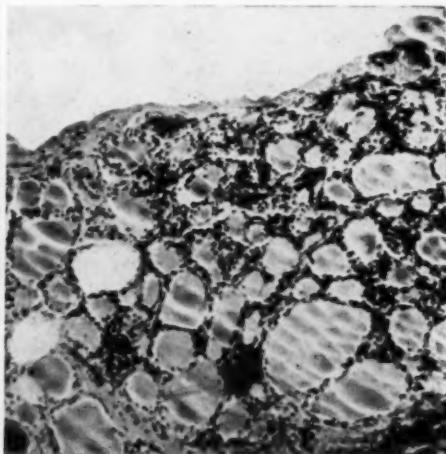


FIG. 2.                                             FIG. 3.

FIG. 2.—Shows photomicrograph of surface of goitre cut with knife.
FIG. 3.—Shows photomicrograph of goitre cut electrically. It will be noted that the surface destruction is slight but the electric current gives sufficient coagulation to prevent all oozing and bleeding from smaller vessels.

it is possible to excise a localized infected area completely, where anatomic conditions permit, leaving a surface surgically clean and with unimportant superficial destruction of tissue so that there will be normal healing in the majority of instances. To determine the possibility of cutting through infected areas without spreading infection, the following procedure was carried out: A good-sized section of fresh tissue which had been removed in a breast-cancer operation was heavily smeared with a culture of staphylococcus. This area was removed with the electric cutting loop. After the infected surface had been excised, several pieces were dropped into culture media. There was no growth in any of these tubes, showing that it is possible to cut electrically through an infected area without danger of contamination. It is my clinical observation that while certain electrically cut tissues heal

satisfactorily, skin and subcutaneous tissues do not heal so rapidly as if cut with a sharp scalpel. This agrees with Ellis's experimental findings[9] that with dogs the skin healed *per primam* in only 60 per cent. with electric cutting and in 97½ per cent. with knife wounds: while with muscle, for practical purposes, electrically produced and knife wounds healed equally as rapidly and with equal strength of union. Hence it has seemed to me desirable to limit the amount of electric cutting as much as is possible in tissues giving less favorabe healing. To obtain the advantages of electro-coagulation which seals vessels much more securely than electric cutting I have in certain operations surrounded the area just inside the line of proposed excision by coagulating punctures, one-half inch apart. Experimental work as previously mentioned shows that electric coagulation extends the clot approximately one-half inch along the vessels. Hence, if punctures are made one-half inch apart, it would seem fair to assume that the clotting would extend in a radius of at least one-quarter of an inch surrounding the puncture. It is possible by using the electro-coagulating spatula to puncture down and completely surround certain cancerous areas, effectually closing the blood-vessels and lymphatics so as to prevent metastasis in handling the tissues. The line of skin incision is then made with a scalpel just outside the electro-coagulated puncture line, and in breast-cancer operations the flap is further reflected by using the scalpel. As muscle healing seems to be good with electric cutting, muscle attachments may be divided by the cutting current. How much advantage will be gained by this procedure will have to be determined by experience, but it is certain that the vessels and lymphatics surrounding a growth can be effectually closed in this way.

Two difficulties in the use of electro-surgery are common to other operations than those for malignancy and goitre; these are, first, the difficulty in cutting through thick layers of fat; and, second, the contraction of muscles as they are cut. These difficulties can be obviated to some extent, but fat is such a poor conductor of electricity, as well as of heat and cold, that it requires a stronger current and more rapid cutting to divide thick layers of fat. Fortunately, the layers of fat are usually subcutaneous and in most cases important vessels and lymphatics through which cancer cells are carried, freeing metastases, are more deeply located, and it is possible with coagulating-current punctures to block off the area adjacent to the malignant growth as I have already suggested in this paper, where the cutting current would be much less certainly efficient.

The contraction of muscles caused by electric stimulation when the electric cutting is used would decidedly interfere with careful dissection under certain conditions. In operations like that for breast cancer the attachments of the muscles to the chest wall are readily divided, specially accurate dissection not being required. When one becomes accustomed to working with electric cutting the muscular contraction usually gives little annoyance and is of no practical consequence. Certain makers claim that their apparatus

can be used without causing muscular contraction but this has not been true of the three different types of apparatus which I have used.

In previous papers, one presented before this association[10, 11] I have urged the value of combining the use of radium with surgery in the management of malignancy, especially when the thyroid is involved. A considerable number of apparently hopelessly bad cases have survived five to fifteen years following such treatment. The large experience of Swedish surgeons and radiologists has been reviewed by Fosell[9] and he also believes that the combination of surgery and radium gives the best results in certain forms of malignancy.

That electro-surgery has not come into use as widely or as rapidly as its merits seem to warrant has not been because of lack of endorsement by recognized authorities. None would question the statements of Harvey Cushing, Howard A. Kelly, and others as to the value of electro-surgery in their fields of work, and the advantages are as valid as concerns its use in many other fields in surgery. It is not adapted for all operations but it is helpful in many goitre operations and its value is great enough so that there seems little doubt but that electro-surgical outfits will eventually become a part of the operating-room equipment of all hospitals.

## REFERENCES

[1] Adult Learning, Prof. E. L. Thorndike, Columbia Univ.: Macmillan Co., New York.
[2] Virchow's Archiv., vol. lviii, p. 547, 1876.
[3] Virchow's Archiv., vol. lv, p. 254.
[4] Neoplastic Disease, p. 903, Philadelphia, 1922.
[5] Arch. franco-belges de Chir., vol. xxv, p. 1047, 1922.
[6] Surg., Gynec. and Obstet., vol. lii, p. 521, February 15, 1931.
[7] Transactions of American Association for the Study of Goitre, 1930, Western Journal of Surgery.
[8] Surg., Gynec., and Obstet., vol. lii, p. 508, 1931.
[9] Surg., Gynec., and Obstet., vol. lii, p. 516, 1931
[10] ANNALS OF SURGERY, p. 338, September, 1922.
[11] Journal of American Medical Association, vol. xc, p. 508, 1928.
[12] Acta Radiol., Sup. 2, 1928.

# PARATHYROIDISM AND PARATHYROIDECTOMY

By Max Ballin, M.D. and Plinn F. Morse, M.D.

of Detroit, Michigan

from the surgical and pathological departments of harper hospital

History.—The connection of parathyroidism with osteomalacic conditions has a most interesting history covering a period of twenty-five years. Much of it has been given in recent publications so that only a brief outline is recalled here. (For closer study of the historical development see Hunter, Barr and Bulger, Compere, et al.) Von Recklinghausen, in 1904, first described osteitis fibrosa cystica in a classical paper which brought to the condition the name of von Recklinghausen's disease of bone. In 1909, DeCosta gathered eight cases of parathyroid tumors from the literature, one of them his own. It is interesting that neither von Recklinghausen in his article on osteitis fibrosa cystica mentioned the parathyroids, nor DeCosta in his article on parathyroid tumors, mentioned the connection with skeletal diseases. Askanazy, in 1904, published the first case of parathyroid tumor found post-mortem in a case of osteitis fibrosa cystica. Erdheim, in 1907, saw the two conditions associated three times, and made the first attempt to connect them etiologically, claiming that the parathyroid hyperplasia was due to the effort of the gland to increase calcaemia. (Erdheim's theory.) Hoffheinz, in 1925, gathered forty-five cases of parathyroid tumors, twenty-seven of them were complicated by disease of the skeleton. In the same year Mandl achieved the distinction of performing the first parathyroidectomy successfully for the cure of osteomalacic conditions. It is interesting to note that Mandl then was not sure at first whether the condition was due to hyper- or hypoactivity of the parathyroids. He tested the matter by first transplanting more parathyroids into his patient and observed a distinct increase in the severity of the symptoms; thereupon he removed the transplant plus the patient's own parathyroids.

*Symptomatology.*—The symptomatology of parathyroidism has also been given fully by the same authors mentioned above and by others. Just as myxœdema and Graves' disease are antithetic conditions in the pathology of the thyroid gland, so in the parathyroid, we have two conditions opposing each other, namely, tetany and parathyroidism.* For the understanding of the condition, however, it is useful to tabulate the opposing symptoms. In tetany, the parathyroids may be diseased, but more often they are injured

---

* We believe that the word parathyroidism should replace the longer term hyperparathyroidism because thyroidism means the same as hyperthyroidism, and hyperparathyroidism does not tell us any more than parathyroidism. It also reminds us that opposing symptoms are not simply due to lessened or increased function of the affected gland, but that various clinical states will have to be interpreted as dysfunctions with mixtures of hyper- and hypo-elements in the same patient (Ballin and Morse, l. c.).

or removed during goitre operations; in parathyroidism, the parathyroids are hyperplastic or adenomatous. The bones in tetany are not affected (the infantile tetany of rickets has a different mechanism and constitutes an exception to this statement); in parathyroidism, however, the bones are generally and locally demineralized and fragile. The muscles are, in tetany, clonic (tetanic); in parathyroidism, weak and hypotonic. In tetany the irritability of the nerves and muscles is greatly increased; in parathyroidism there is a condition of relaxation and the threshold of stimulation is raised. The normal muscle responds to 4 milliamperes of current; in parathyroidism 10 milliamperes or more is necessary to produce contraction (Oppel). The chronaia is diminished, and returns to normal after parathyroidectomy (Bourguignon and Sainton). Blood calcium in tetany is low (4 to 6 milligrams per 100 cubic centimetres blood serum); in parathyroidism the blood calcium is high (11 to 20 milligrams). Blood phosphorus in tetany is increased; in parathyroidism decreased (1 to 2 milligrams). In tetany the treatment is to administer parathormone and calcium; in parathyroidism removal of the hyperplastic glands is indicated. (Administration of parathormone makes parathyroidism worse, in fact may produce it if given in over-doses for a long time.)

| | In tetany | In parathyroidism |
|---|---|---|
| Parathyroids | diseased injured or removed | hyperplastic or adenomatous |
| Bones | not affected | generally and locally demineralized, fragility |
| Muscles | clonic (tetany) | hypotonic |
| Nerves | irritability | quiet |
| Calcium | low (4 to 6 milligrams) | high (12 to 20 milligrams) |
| Phosphorus | increased (10) | low (1 to 2) |
| Therapy | Parathormone plus calcium | Removal of hyperplastic and adenomatous parathyroids |

The main symptoms of parathyroidism are those of the skeleton—generalized demineralization of bones with localized areas of rarefaction. In the Roentgen-ray this is evidenced by lack of lime salts in the bones, more or less throughout the skeleton. The roentgenogram looks as though the plates were under-exposed. Rarefaction in localized areas may be caused by giant-cell tumors or cysts, and these should be regarded as changes in the bone tissue resulting from decalcification. These giant cells are not neoplastic, but the response to the decalcifying process. Bleeding into the demineralized areas or into the giant-cell tumors often results in cyst formations. Altogether, this is the picture of von Recklinghausen's osteitis fibrosa cystica.

Demineralization leads to curving of the long bones and spine, diminishing the height of the patient, a sign practically pathognomonic of parathyroidism. The stooped-over appearance of these patients, with the neck drawn in, the shoulders coming forward, lower ribs approaching the iliac spine, the flattened pelvis, has been described in every well-developed case.

The vertebral bodies also become flattened and finally show compression fractures. Frequent fractures of the ribs, vertebræ and long bones should remind us of parathyroidism, especially if metastatic malignancy can be ruled out. Severe pain in the affected bones is practically always present. Some of the patients have spent months and sometimes years in bed, or with corsets and other supports in the effort to relieve this pain. The pain may be caused mostly by pressure on the intervertebral nerves, by the deformed vertebræ, but the hypercalcæmia most likely is the more important underlying factor, judging by the prompt relief which follows operation. The demineralization of the skeleton leads to the increase of the serum calcium, and to increased calcium excretion in the urine. Just as the liver is the storehouse for glycogen, so the spongiosa of the skeleton is the storehouse for calcium. Donald Hunter and several others have written most explicitly on this topic. In parathyroidism the spongiosa of the bones gives out calcium too rapidly. Later in the disease the cortical substances of the bones also suffer. The increased calcium content of the blood is one of the main symptoms of parathyroidism. We find readings up to 20 milligrams (25 milligrams exceptionally), the normal being 8 to 9 milligrams; *however, hypercalcæmia can be temporarily or continuously absent, and if so should not exclude the diagnosis of parathyroidism if all other symptoms speak for it.*

Careful metabolic work on the calcium metabolism has shown that in parathyroidism there is a negative calcium balance, that is the calcium excreted in stool and urine is six or seven times greater than normal. The excretion is greater than the intake, even with high calcium diets and the bones are progressively decalcified. The importance of the changed phosphorous metabolism (lowered serum P.) goes with the calcium disturbance; some think it is more important than the calcium.

Metastatic calcium deposits in parathyroidism have been lately emphasized and made a part of the symptom complex through the work of Oppel in Leningrad. It has been proved that such calcium metastases can also be produced by free hypodermic administration of parathormone. In Roentgen-rays taken in parathyroidism, we see large calcium deposits around the bodies of the vertebræ, and anterior-vertebral ligament; the lumbar ligament shows diffuse calcification or calcium deposits. Perhaps the occasional very early deposits of calcium in blood vessels of young people is also due to this endocrine disturbance. Metastatic calcifications have also been found in the mucosa of the stomach, heart, thyroid and adrenal cortex in parathyroidism. Oppel believes that in ankylosing multiple arthritis, the initial focal infection is the nidus for the deposition of lime in patients predisposed to metastatic calcification by parathyroidism. Oppel claims, after extensive investigation, that in practically all ankylosing types of polyarthritis there is a moderate hypercalcæmia, averaging 12 milligrams of calcium per 100 cubic centimetres of serum. His studies have been published after operations on seventy such cases in 1928, and were done in the hospital where Bechterew made his studies

of the ankylosing types of spondylitis. Metastatic calcium with ankylosing polyarthritis and hypercalcæmia should, therefore, be taken into the symptomatology of parathyroidism.

The question whether all these symptoms should be attributed to parathyroidism has been much discussed and has been answered in the affirmative for two reasons: First, symptoms, characterizing the condition, bony as well as muscular, have been artificially produced by giving over-doses of parathyroid extract; second, all symptoms have been cured by removal of the hyperplastic parathyroids. Barr and Bulger, *et al.*, produced hypercalcæmia by giving over-doses of parathormone, or by giving normal doses over long periods of time. Huper produced calcium metastases by giving injections of parathormone over a long period of time. Dogs were noted by Collip to be apathetic after such injections, and this apathy is observed clinically in patients with parathyroidism. Atony of muscle and nerves has also been produced experimentally.

At present there is no settled general agreement as to just which of the deficiency diseases of bone should be referred to parathyroidism. Hoffheinz in his collection of twenty-seven cases of the combination of parathyroid tumors and skeletal diseases found general osteitis fibrosa seventeen times, osteomalacia eight times, and rickets twice. In Compere's compilation of twelve cases of parathyroidism, six had general osteoporosis and six had general osteoporosis with cysts. Hunter writes: "There can be little doubt that the essential change in generalized osteitis fibrosa is a removal of calcium from the skeleton owing to parathyroid hyperactivity."

General decalcification and osteitis fibrosa cystica as an entity should certainly be called parathyroidism. The true pathologic picture has been produced artificially in animals by repeated injections of parathormone, and at least fifteen parathyroidectomies reported in the literature as well as our own have given such results that the parathyroid origin of osteitis fibrosa cystica cannot longer be doubted. (Mandl, Hunter, Oppel and associates, Barr and associates, Snapper, Aub and associates, Pemberton, Quick and Hunsberger, Leri and associates, Bourguignon and associates, Ballin and Morse.)

Multiple ankylosing arthritis (Oppel) should also be included in the chapter of parathyroidism. The metastatic calcification around infected joints, especially vertebral joints, is based on a moderate hypercalcæmia; at the same time nearly all these arthritides develop kyphosis. The spinal column bends just as in decalcification, and a few vertebræ become compressed the same as in osteitis fibrosa cystica. Besides the rarefied areas, some hyperostotic places always show in Roentgen-ray.

Oppel based his observations on seventy parathyroidectomies which he had already performed up to 1928. His statement that ankylosing polyarthritis is accompanied by hypercalcæmia, lessened irritability of muscles and nerves (therefore stiffness of the muscle), and psychic quietness of the patients, should suggest that we put this group under parathyroidism. In
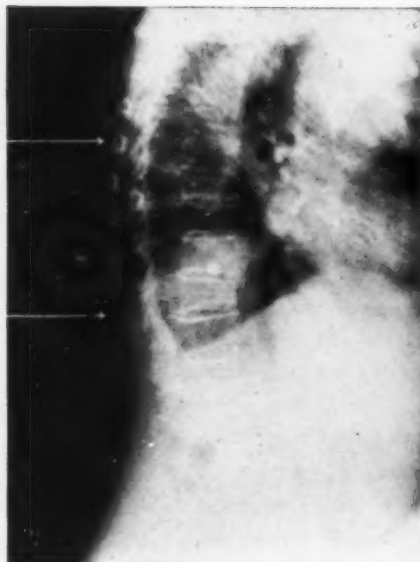
FIG. 1.                                        FIG. 2.

FIG. 1.—Case XV. Female, aged fifty-two. Arthritic pains for five years. Height lessened 2 inches. Marked kyphosis. Blood calcium 12.8-14 milligrams. Immediate relief of pain after parathyroidectomy. Area between arrows indicates demineralized and crushed vertebræ.
FIG. 2.—Case XV. Demineralization of head of right femur. Note the heart-shaped pelvis.



FIG. 3.—Case XV. Demineralized and curving femur.
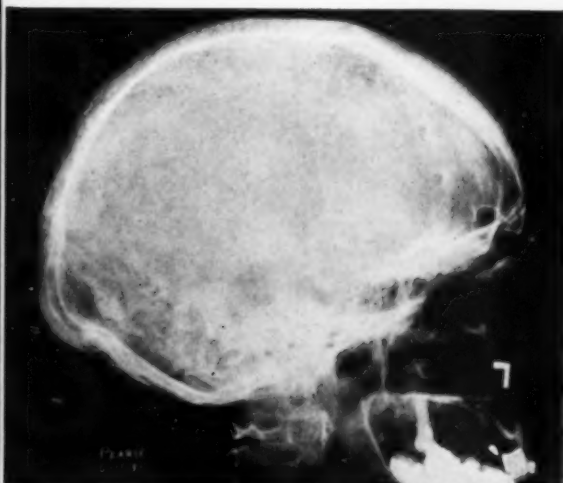
FIG. 4.—Case XV. Skull; beginning Paget type.

596

forty-one cases of this affection, Oppel found the calcium at the upper limits of normal in practically all. The results of his operations demand attention. On thirty-one patients the results were studied from seven months to two years. Sixteen were improved. This percentage is a high one when we consider that Oppel always performs only a unilateral thyroparathyroidectomy and that in eleven cases out of the thirty-one the removed parts did not show parathyroid tissue. Incidentally this speaks against unilateral operation and in favor of always investigating both sides of the neck for parathyroids.

Our own observations comprise fifteen parathyroidectomies. Six had general demineralization of the skeleton with demineralized foci in the vertebræ and other bones. Seven had a combination of demineralization of the spine leading to kyphosis with stiffening or ankylosing arthritic joints. (Oppel type.) In one of them only the joints of the extremities were affected and this case has been operated too recently to comment on the results. Otherwise, the results of the operation seem to show that it belongs to this group. We realize that many of them have not been observed long enough to warrant ultimate conclusions, and a check-up will follow. The results of our observations allow the conclusion that general demineralization of the bone as well as osteitis fibrosa cystica and multiple ankylosing arthritis combined with signs of disturbed calcium metabolism belong to the parathyroid group. The so-called Paget's disease was usually reported separate from von Recklinghausen's osteitis fibrosa cystica in literature and textbooks. From our clinical observations this seems to be a wrong classification. Our autopsied case reported in our former communication showed parathyroid tumor, multiple giant-cell tumors in bones with multiple areas of osteitis fibrosa cystica, and the condition of the skull generally would be classified as Paget's disease. We have a case under observation now, not operated so far (Mr. F. T.), with a typical X-ray picture of osteitis fibrosa cystica plus an immense Paget's skull. Another case of this same type and of the same combination, has been shown to us through the kindness of Dr. Hugo A. Freund, from the Medical Department of our hospital. A third such combination is reported by Bourguignon and Sainton, who state naïvely that their patient suffered from Paget's disease of the skull and femora, from osteitis fibrosa cystica of the pelvis, and decalcification of the humerus, and a large bony tumor of the maxilla. To be sure, this observation and many others, should suffice to prove that Paget's disease and osteitis fibrosa cystica belongs to the same group and should be classified as parathyroidism. Apropos of the large bony tumor of the jaw, Bourguignon states that it showed microscopically "an osteolytic process with fibrous hyperplasia"— a typical picture of osteitis fibrosa cystica. This leads to the question whether leontiasis ossea and cysts of the jaw belong to the parathyroid group. In a very interesting article by Hamburger, of Baltimore, leontiasis ossea is considered to be only a local variation of osteitis fibrosa cystica affecting the maxilla. At the time of Hamburger's article parathyroidism was not con-

597

sidered in connection with this affection. Supporting Bourguignon's publication, we have had under observation for several years a tumor of the maxilla which had been removed elsewhere with a diagnosis of sarcoma of the jaw (just as legs have been amputated for giant-cell tumor of this type). The patient is a woman who looks exactly like Hamburger's patient with



FIG. 5.—Case F. T., ♂, aged sixty. Recent operated case with findings resembling Paget's disease and osteitis fibrosa. Note marked kyphosis, enlarged skull (head-size changed from 6⅞ to 8⅛).

FIG. 6.—Case F. T. Note drawing in of head between shoulders and approach of costal arch to pelvis. Left tibia, Paget type.

leontiasis ossea. Three or four years after her jaw resection, the process not only extended further into the jaw, but, when one day her complaints of backache led us to take more Roentgen-rays, a diffuse osteitis fibrosa cystica of the spine, pelvis, femora, *etc.*, was found. Illustrating the endocrine

element present in this case a brother of this patient complained of gall-bladder pain, and the Roentgen-rays which were taken showed incidentally multiple osteitis fibrosa cystica; and now another sister gives the same Roentgen-ray picture. Such observations obviously suggest most vividly that leontiasis of the maxilla belongs to the parathyroid group. We have Roentgen-rays of three members of another family with vertebral changes, characteristic of parathyroidism. We have not enough clinical evidence so far to classify the multiple cysts of the mandible in this group.

There is another group of rarefaction of bones which in other classifications is called a one-bone type, in which perhaps the Perthes, Kohler, Osgood and Kienbock types of osteitis belong. As proof for this type being of parathyroid origin we can only say that one of our patients (Case III) started as a one-bone condition in the tarsus, and another (Case V) started as a single-bone condition in the upper part of



Fig. 7.—Case F. T., ♂, aged sixty. X-ray of spine. Note demineralization and compression fracture.
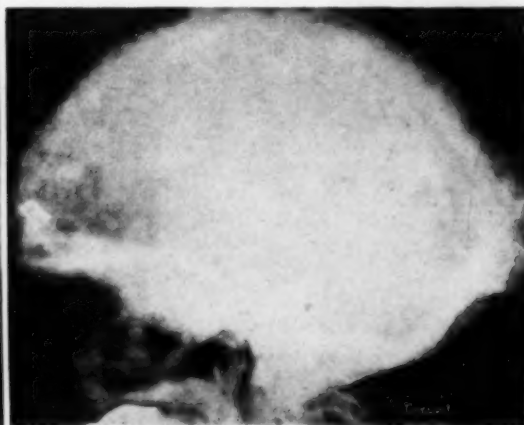
Fig. 8.—Case F. T. Figs. 7 and 8 show combination of osteitis fibrosa and Paget type.

the left femur, and that both cases were practically cured by parathyroidectomy. The same observation was made by Bourguignon and others.

*Early diagnosis.*—The clinical diagnosis of parathyroidism in its *initial* stages should and will be made very frequently. After having trained our younger men and röntgenologists in recognizing the early symptoms, hardly a day passes that we do not pick up in our large dispensaries cases that clinically show the initial symptoms. In the beginning of all new surgical chapters only the far-progressed cases are referred for surgical interference. The older ones of us still remember the sad paratyphlitic abscesses in appendiceal surgery; the jaundice and septic gall-bladders of the 90's; the fetid-smelling bladders in beginning prostatic surgery; and the critical thyroid cases that were first introduced to the surgeon. It was uphill work to convince our colleagues that early surgery means results. Late reference means

surgical derelicts as they are called. Logic should prevent this from happening again in parathyroidism.

Of the twenty to thirty cases of parathyroidism published so far practically all were extremely decalcified, had several fractures, were bent over and had ankylotic spines. To be sure most of this damage cannot be repaired. The operation in these far-progressed cases, with the chin approaching the chest, is technically difficult. With the exception of Pemberton's case and two or three of our own, the disease was very far advanced before operation was resorted to. In spite of this, in far-advanced cases of Quick and Hunsburger, of Snapper, and in a case seen by us with Dr. Grover Penberthy, and our own cases I, II, III, XVI, improvement was immediate as far as relief of pain is concerned, and encouraging in the improvement of function and the return of calcium into the bones. We could logically expect more if the early cases are operated upon. The diagnosis should be made early on the symptoms of pain, beginning demineralization and beginning compression of vertebræ, or on beginning bone cysts, before the whole sad picture is established. If we look for these early symptoms the number of patients found to be suffering from parathyroidism will be very large. The skeletal symptoms are likely often covered up in the patient's complaints by intestinal upsets (de Pemberton), muscular weakness, burning sensation in skin (as known also to be caused by the sudden hypercalcæmia after intravenous injection of calcium chloride).



FIG. 9.—Mrs. I. McG. Early case in young woman twenty-six years old, showing ankylotic kyphosis. Blood calcium 12-14 milligrams, and X-ray findings of wedging of upper dorsal vertebræ and hypertrophic arthritis. Parathyroidectomy gave relief of pain.

Here two points should be prominent in our minds: First, how is this picture to be recognized early; and second, if recognized, is the operation so void of danger that early operation is justified. Late operation is obviously indicated, because these people suffer so much pain and are so crippled that life is not worth living. Take the second question first—the danger of the operation. In the cases reported in the literature, including our own, only the case of Beck was followed by fatal tetany. The two fatal cases of Toland three months after operation obviously do not belong to this group. They were cancers or malignancies of the parathyroid, and had no bone complications whatever. Severe post-operative tetany followed

in our first case, but was promptly taken care of and subsided entirely after parathormone and calcium administration was instituted. The same happened in Snapper's case. Severe tetany after operation is also reported by Barr and Bulger, and it seems that this patient needed parathormone and calcium for several months after operation. In one of our fifteen cases bleeding happened from the inferior thyroid artery, the ligature slipping from the parathyroid branch. The wound had to be packed and tracheotomy had to be done to overcome the pressure of the hæmatoma. The patient made an uneventful recovery. We had to do one more tracheotomy for paresis of the vocal cords lasting a few days. We had no fatalities. We must realize that fatal cases are not reported in the beginning of new surgical chapters, but in all, we have the impression that the operation itself involves no more risk than one of the more difficult goitre operations. With more knowledge of the fine anatomy of the parathyroids and the delicate work of removal, the dangers of tetany, nerve lesions and hæmorrhage will undoubtedly lessen. From the technical side no opposition should be shown this operation. Neither should there be any great objection because of the fear of post-operative tetany. This happens relatively seldom, and parathormone will bridge the patient over the post-operative period. If thyroid history repeats itself in parathyroid history we should remove at least two bodies if there are no real adenomata present. Otherwise the results will not be good. Oppel has done seventy unilateral thyroparathyroidectomies without any post-operative tetany. To be sure his operations on only one side should not be encouraged as he had missed the parathyroids a good many times and often removed only one, and therefore his results were not more than 61 per cent. successful.

The abdominal symptoms in the course of parathyroidism are very interesting. They are most likely due to the disturbance in calcium and phosphorus. It is remarkable that in Pemberton's case the gastric symptoms, vomiting, *etc.*, were prominent and dominated the picture for many months before Pemberton made the diagnosis and cured the patient by removal of the parathyroid adenoma. Our Case VI is a woman who had been treated for many years for intestinal symptoms without accurate diagnosis ever being made. She acquired an argyria from the long years of treatment with silver salts, but since parathyroidectomy, the skin has become much paler. It is known that calcium combines with lead in the body and that removal of lead from the body is accelerated by calcium administration. In a similar way Gettler, Rhodes and Weise suggest that silver combines with calcium and therefore is perhaps available for elimination like lead through hypercalcæmic processes.

The urinary symptoms are very frequent in parathyroidism, probably due to the calcæmia. Calculus formations are also frequent complications as well as smarting and frequent urination and polyuria.

Interlocking disorders of other endocrine glands are also present. The thyroid may have a part in producing calcium disturbances. Many of our
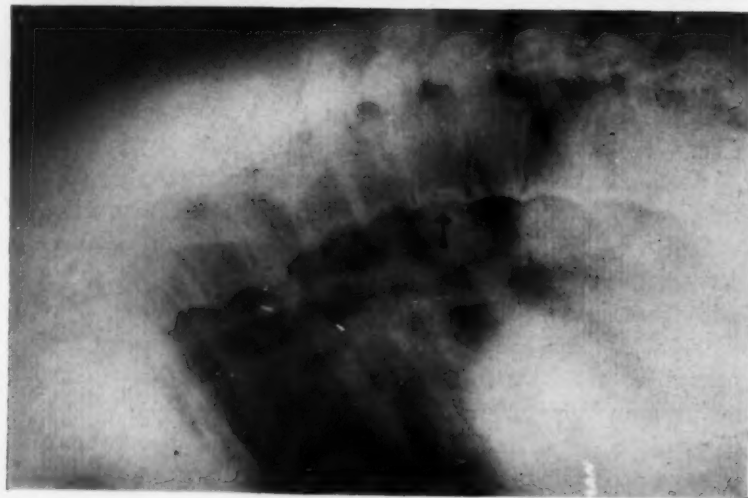
FIG. 10.—An early case of Oppel's type. Blood calcium 14 milligrams. Pain severe. The arrows indicate wedging, with a diminution of intervertebræ discs and calcification of the antero-vertebra ligament.

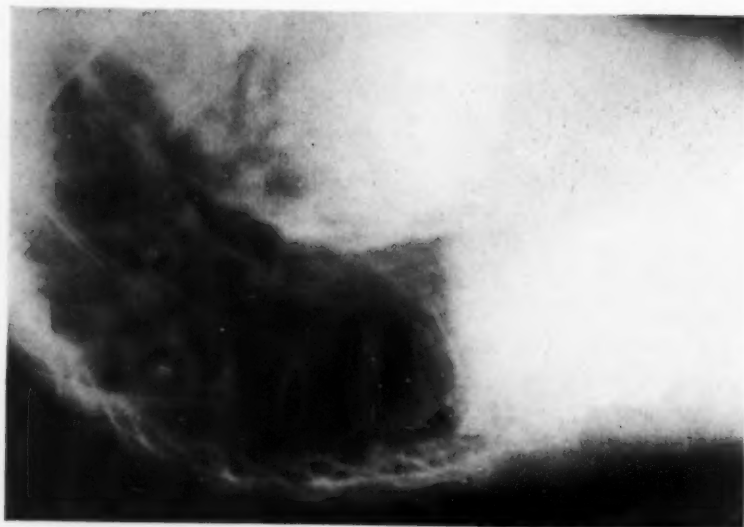FIG. 11.—Symptoms as in Fig. 10; less pronounced. Diagnosed early, but shows wedging and overgrowth.

FIG. 12.—Mrs. S. Long-standing senile type.

cases had goitres. One of our cases of typical acromegaly had kyphosis and the spine of a parathyroidism. Diabetes was observed in our Case I. Albuminuria was observed twice (Cases VIII and XIII). Head, Shumaker and associates wrote an article on the Association of Diabetes Insipidus with Osteitis Fibrosa Cystica. The appearance of symptoms after hysterectomies, surgical menopause after confinement is noticed in our Cases III, VI, IX and XVI.

Eight of our cases all showed the picture of demineralization, high calcium, rarefied areas in the bones and calcium deposits around the vertebral bodies, ligaments, *etc*. In every one of these patients it is remarkable that immediate improvement followed operation. The patients state there is immediate lessening of pain, the limbs feel freer, and the muscles have better tone. The influence on the arthritic process seems to be always present in the vertebral type of arthritis. Not enough time has elapsed since operation to judge the influence on the joints of the extremities but we intend to report about the type of case Oppel writes about with final results later on.

TABLE OF CASES

CASE I.—H. J. B. (Type II), male, sixty-five years. Onset of disease.—1927. Symptoms.—Backache, leg-ache, curved spine. Height diminished two inches. First diagnosis.—Metastatic malignancy (myeloma). Treated with corset. T. B. spine. Luetic spine, 1929. Progress.—Entirely disabled. Used morphine freely. X-ray findings.—General osteoporosis. Compression lower dorsal vertebræ. Demineralization first and second ribs, right femur. Intervertebral discs compressed. Blood Ca.—1929, 11.4; 1930, 8.5; 14.8. Urine.—Sugar 4x. Bence-Jones x. Albumin xx. G. I. Symptoms.—Gas. Metastatic calcifications—In aorta, iliac arteries, lungs (was thought tubercular). Diagnosed parathyroidism.—1930, R. C. Moehlig. Operation.—May 31, 1930, right thyroid lobectomy. Right lower parathyroidectomy. Two doubtful bodies. Microscopy.—Two parathyroids. Vascular. Adenomatous. Cystic. Post-operative course.—Stormy, delirious one to two weeks (Tetany?). Final recovery.—Pain stopped. Ca normal after ten months. Gained weight. Enjoyed life again. Ca returning into bones. No progress of destructive process.

CASE II.—R. C. (Type II), male, fifty-five years. Onset of disease.—January, 1930. Symptoms.—Backache. First diagnosis.—First sacro-iliac, then intervertebral arthritis; then malignancy of spine. Progress.—Disabled; needs crutches. X-ray findings.—General demineralization iliac spine, skull, arms, left fibia and spine. Compression fracture lower thoracic segment. Intervertebral arthritis. Blood Ca.—11.3; 18.6. Urine.—o. G. I. Symptoms.—o. Metastatic calcifications.—Pelvic vessels. Diagnosed parathyroidism.—August, 1930, Wm. A. Evans. Operation.—September 13, 1930, subtotal thyroid lobectomy (bilateral); left, one body-; right, two bodies. Microscopy.—Two parathyroid bodies. Round-cell infiltrations. Post-operative course.—Smooth. Final recovery. Ca stayed up around 13 for six months after operation. Now normal. Pain gone. Returned to work May, 1931. Ca returning into spine May, 1931. No progress of the destruction.

CASE III.—M. M. (Types II and III, female, sixty-three years. Onset of disease.—1927. Thyroidectomy for adenomatous goitre. Symptoms.—1930. Pain in right foot; later in back. Had to use crutches and stay in bed a good deal. First diagnosis.—Arthritis (Kohler's type). Progress.—Later backache and kyphosis. X-ray findings.—Arthritic process in right tarsus with demineralization (scaphoid especially) suggesting osteitis fibrosa. Arthritis of spine. Blood Ca.—11; 14.6; 9.2. Urine.—o. G. I. Symptoms.—o. Metastatic calcifications.—Abdominal aorta. Diagnosed parathy-

roidism.—December, 1930, Wm. H. Gordon. Operation.—December, 1930, two lower parathyroid bodies removed from thyroid. Microscopy.—Two parathyroids with cyst formation. Marked fibrosis. Post-operative course.—Good. Final recovery.—Fine. Gained 20 pounds in six months. No pain. Discarded crutches. Ca stayed 11 for three months.

CASE IV.—R. M. (Type IV), female, fifty-seven years. Onset of disease.—1927, short spell of backache. October, 1930, more severe; sleepless. First symptoms.— Spondyloarthritis. Progress.—Kyphosis. Becoming shorter. X-ray findings.—Demineralization of vertebræ and radius with reduction of height of bodies. Blood Ca.—14.6; 11.6; 9.2. G. I. Symptoms.—Frequent vomiting. Diagnosed parathyroidism.—R. C. Moehlig. Operation.—February 9, 1931, adenoma of thyroid. Bilateral subtotal lobectomy. Two lower parathyroids. Microscopy.—Adenomatous parathyroids; fat spaces; no acidophile cells. Post-operative course.—Hœmorrhage of left inferior thyroid; required packing and tracheotomy. Finally O. K. Final recovery.—Splendid. Pain gone. May, 1931, Ca 10. June, 1931, Ca 11.6. No X-ray check so far.

CASE V.—J. M. (colored) (Types II and III), female, thirty years. Onset of disease.—Started at age of thirteen. Fractured left leg below hip. 1926, Myomectomy after this. Symptoms.—Leg became painful; also left elbow. First diagnosis.—Bone cysts of femur with fracture. Progress.— Crutches and much of time in bed. X-ray findings.—Cyst-like process left; ilium and left acetabulum; head neck and upper third of left femur. Less in right ilium. Osteitis fibrosa cystica left elbow. Slight old fracture external condyle (not known to patient). Blood Ca.—11. Diagnosed parathyroidism.—A. R. Bloom. Operation.—February 3, 1931, bilateral subtotal thyroid lobectomy. Two inferior parathyroids. Microscopy.—Two parathyroids. Adenomatous. Hœmorrhage. Large fat islands. Post-operative course.—Good. Final recovery.— Fine. Walks without crutches or splint. No more pain. May, 1931, large cyst process in femur and os ilium less in size. Beginning calcification.

CASE VI.—H. G. (Types I and IV), female, forty-seven years. Onset of disease.— 1916, pelvic inflammatory disease, salpingectomy. 1921, hysterectomy. Symptoms.— 1930, backache, pain in liver region, vomiting. First diagnosis.—Gastric ulcer with cholecystitis. Progress.—High kyphosis. X-ray findings.—Lateral and posterior curvature of dorsal spine. Calcification of intervertebral discs. Wedging of vertebræ. Erosion of spinal joint. Blood Ca.—11.2, 11.2. Urine.—0. G. I. Symptoms.—Gastric disturbance ten years. Much treatment. Developed argyria. Metastatic calcifications.—Marked calcification of costal cartilages. Diagnosed parathyroidism.—R. C. Moehlig. Operation.— April 23, 1931. Bilateral lobectomy of adenomatous thyroid. Two parathyroids. Microscopy.—Biological test.—Parathyroids transplanted in case of tetany with cessation of tetany. Post-operative course.—Smooth. Final recovery.—Fine. No pain. No gastric symptoms for two months since operation. June, Ca 11.2.

CASE VII.—A. M. R. (Type IV), male, fifty-three years. Onset of disease.— January 19, 1929. Operated for toxic adenomatous goitre. Symptoms.—Paralysis agitans. First diagnosis.—Paralysis agitans, arthritis. Progress.—Later developed Parkinson's syndrome. X-ray findings.—Spondylo-arthritis. Blood Ca.—10, 9, 8. Urine.—0. G. I. Symptoms.—0. Diagnosed parathyroidism.—R. C. Moehlig. Operation.—May 12, 1931. Parathyroidectomy. Two small parathyroids removed. Microscopy.—Adenomatous, cystic changes. Post-operative course.—Smooth. Final recovery.—No progress of symptoms.

CASE VIII.—McA. (Type IV), female, twenty-six. Onset of disease.—1929, after pregnancy, painful curved back. Symptoms.—Stiffness and pain in back. High dorsal kyphosis. Resisting good orthopædic care. First diagnosis.—Infectious arthritis. Progress.—Severe painful joints, causing insomnia. X-ray findings.—Marked dorsal kyphosis, intervertebral spaces diminished, so that anterior processes of segments approach each other. Diminished width and narrowing of three vertebræ. Blood Ca.—10.4, 11. Urine.— Pyelitis. Dysuria at times. Diagnosed parathyroidism.—R. V. Funston. Operation.—

May 18, 1931. Bilateral thyroid lobectomy. Two inferior parathyroids removed. Microscopy.—Biologic test. Parathyroids transplanted into case of tetany with relief of tetany which had lasted three years. Post-operative course.—Smooth. Final recovery.—Feels fine. Immediate results lasting one month. Free of pain for first time in two years.

Case IX.—I. McG. (Type IV), female, thirty-two years. Onset of disease.— Since confinement two years ago. Symptoms.—Pain in back. Shoulders becoming round. First diagnosis.—Infectious arthritis. Progress.—Partially disabled, unable to lift anything from floor. One foot becomes blue and cold. X-ray findings.—Arthritic changes with areas of decalcification in spine. Blood Ca.—12.8. G. I. Symptoms.— Appetite poor. Operation.—May 26, 1931. Both large lobes of thyroid removed, one small right inferior and larger left inferior. Microscopy.—Biologic test. Parathyroids transplanted into case of tetany existing three years, costing city $1,200.00 a year for parathormone. Has not needed parathormone for five weeks since operation. Post-operative course.—Smooth. Final recovery.—Cessation of pain. Observation period too short for further report.

Case X.—M. M. (Type IV), female, fifty-six years. Onset of disease.—Twelve years ago. Symptoms.—Painful back, shoulders, knees, arms involved. First diagnosis.—Infectious arthritis. Progress.—Severe pain. X-ray findings.—Demineralization plus hypertrophic arthritic process around spine, joints and knees. Blood Ca.—11.6, 12.5. Urine.—0 G. I. Symptoms.—0. Metastatic calcifications.—In anterior arterio-vertebral segment. Operation.—May 23, 1931. Bilateral subtotal thyroidlobectomy for adenomatous goitre. Goitre surrounded by much fat but two small parathyroid bodies removed. Microscopy.—Large adenomatous goitre. Post-operative course.—Smooth. Final recovery.—Immediate relief of pain (only three weeks of observation).

Case XI.—J. K. (Types II and III), male, forty-four years. Onset of disease.— Bending forward of back for ten years. Symptoms.—Pain in back and hips. Weakness. Shortness of breath. Loss of two inches in height. First Diagnosis.—Osteoarthritis of vertebræ. Progress.—Spine became fixed. Lower ribs rest on pelvis. X-ray findings.—Extreme kyphosis upper torso, with wedging of intervertebral bodies and demineralization. Blood Ca.—16, 11. Urine.—0. G. I. Symptoms.—0. Metastatic calcifications.—Wedging of 8th dorsal. Operation.—May 28, 1931. Right bilateral subtotal thyroidectomy for adenomatous thyroid. Right inferior and left inferior. Microscopy.— Parathyroids transplanted into case of tetany. Tetany ceased. Post-operative course.— Smooth. Final recovery.—So far good results as to pain.

Case XII.—J. B. (Type IV), male, fifty-three years. Onset of disease.—Arthritis symptoms six months. Symptoms.—Stooping over of head and shoulders. First diagnosis.—Infectious arthritis. Progress.—Increasing severity of pain causing insomnia. Slight disability. X-ray findings.—Arthritic changes in thoracic spine. Disalignment. Hypertrophic changes. Blood Ca.—12.5, 11, 11.4. Urine.—0. G. I. Symptoms.—0. Operation.—June 4, 1931. Bilateral subtotal thyroid lobectomy. Two lower parathyroid bodies removed. Microscopy.—Parathyroids hypertrophic and adenomatous. Post-operative course.—Smooth. Final recovery.—Observation period short. Results good so far.

Case XIII.—B. G. (Type IV), female, fifty-eight years. Onset of disease.—Fifteen years ago. Joint pains following tonsillitis. Symptoms.—Pain in hands and left knee. First diagnosis.—Arthritis deformans. Progress.—Worse after hysterectomy. X-ray findings.—Advanced hypertrophic arthritis of knees. Blood Ca.—11, 10.8. Urine.— Dysuria, one year. G. I. Symptoms.—0. Operation.—June 4, 1931. Bilateral subtotal thyroid lobectomy, two parathyroid bodies. Microscopy.—Islands of parathyroid tissue distributed through fat tissue. Post-operative course.—Tracheotomy performed for relief of dyspnœa. Final recovery.—Observation period short. Recovery good so far.

Case XIV.—B. L. (Type IV), female, twenty-one years. Symptoms.—Arthritis. Both legs and knees. First diagnosis.—Ankylosing arthritis. X-ray findings.—Multiple

ankylosing arthritis of elbows, interphalangeal and knees.  Blood Ca.—10, 11.  Urine.—0.
G. I. Symptoms.—0.  Diagnosed parathyroidism.—R. V. Funston.  Operation.—June 6,
1931, bilateral thyroid lobectomy for adenomatous goitre.  Two bodies removed as
parathyroids.  Microscopy.—Bodies removed as parathyroids proved to be lymph glands.
Still had mild post-operative tetany.  Post-operative course.—Smooth.  Final recovery.—
Case not useful for statistics.  No parathyroid removed.

CASE XV.—G. P. (Type II), female, fifty-two years.  Onset of disease.—Five
years ago with rheumatism.  Symptoms.—Several rib fractures two years ago.  Severe
pain in hip and right groin five months ago.  First diagnosis.—Osteo-malacia, coxa
vara.  Progress.—Limping.  Marked scoliosis of upper spine.  Ribs approached pelvis.
Height shortened two inches.  Spine partially ankylosed.  X-ray findings.  Extensive
demineralization of all bones.  Wedging of vertebræ along lower dorsal segments and
fifth lumbar, general skeletal demineralization, suggestion of Paget's disease of skull.
Blood Ca.—12.8, 11, 14.  Urine.—0.  G. I. Symptoms.—0.  Operation.—June 13, 1931,
thyroparathyroidectomy for adenomatous thyroid, two parathyroid bodies removed.
Microscopy.—No acidophilia.  Diffuse fatty type.  Post-operative course.—Tracheotomy
performed for relief of dyspnœa.  Wound healed.  No inflammation.  Final recovery.—
Startling immediate recovery from arthritic pain.

CASE XVI.—A. S. (Type I and IV), female, fifty-three years.  Onset of disease.—
1925, hysterectomy for fibroid.  Symptoms.—High back pain five months.  Interphalan-
geal arthritis acroparathesia.  First diagnosis.—Spondyloarthritis.  Progress.—Kyphosis,
X-ray findings.—Overgrowth of spinal articulation.  Diminished vertebral disks.  Wedg-
ing of dorsal segments.  Blood Ca.—12, 14, 8.  Urine.—0.  G. I. Symptoms.—0.  Opera-
tion.—June 17, 1931, large left bilateral subtotal thyroid lobectomy for adenomatous
goitre.  Large left parathyroid—adenomatous.  Left smaller.  Microscopy.—Not fin-
ished at the time of this report.  Post-operative course.—Smooth.  Final recovery.—No
untoward results following operation.  Observation period short.

*Pathology.*—The judgment of the condition of parathyroidism seems to
depend entirely upon the clinical symptoms correlated with the Roentgen-ray
findings and the blood-calcium level.  There is very little in the histological
examination of the glands to give a clue to their hyper-functioning state.  In
fact, comparison of the parathyroids taken from normal cases, or from cases
suffering from other diseases, with those of the operative cases of parathy-
roidism, shows differences so small as to be unimportant in diagnosis.  One
or two findings have been noted that may be significant : First, the tendency
to diffuse and focal round-cell infiltration of the gland, which is certainly an
abnormal condition and which is reminiscent of the round-cell infiltration
so common in thyroid adenomata.  Cystic areas filled with a very thin, pale,
blue-staining colloid are noted, but they have also been noted in supposedly
normal organs, and were described by Sandström in his original description
of the anatomy of the epithelial bodies.  They have been considered by others
to represent degenerative changes and may have some significance in this
regard just as the degenerative changes in thyroid adenomata are considered
to be evidences of anatomic breaking-down from functional over-strain.

From a general survey of the parathyroid tissue so far removed by us,
we would say that compact nodules forming in the peri-glandular fat, and
even isolated nodules found in fat tissue not directly connected with para-
thyroid bodies are possibly more significant as indicating a hyper-functioning
state than any of the other changes.  A great deal of significance should be

given to the gross dimensions of the gland as removed at operation. Epithelial bodies vary markedly in their normal dimensions, but it is quite usual in these cases to find an elongated, flattened parathyroid body, with a rather large, rounded superior pole tailing off at its inferior end to a fatty string of tissue, the whole being 1 centimetre or even 1½ centimetres in length. This mass is flattened against the thyroid capsule, taking a triangular shape in cross-section with the surface applied to the thyroid somewhat concave.

The parathyroid, in the case of renal rickets which was autopsied, was a grossly hypertrophic gland about four times the usual dimensions in each direction, extraordinarily compact in structure, but otherwise of normal appearance, giving the impression of a functional hypertrophy from overstrain, rather than from a pathologic condition of the parathyroid body itself.

The true tumors of this organ are quite different. They are only faintly reminiscent of the epithelial body in their structure, except that the large cystic spaces filled by thin blue-staining colloid are very numerous, and are quite characteristic, being identical in structure with those noted above except that they are larger and more irregular in shape. The epithelial tissue between the spaces is distinctly atypical and neoplastic in type. Parathyroid tumors as a whole are rather characteristic and easily recognized. Those described in the literature as malignant and as metastasizing, we think are very doubtful of parathyroid origin, and a serious question may be raised as to their true parathyroid nature.

*Treatment.*—The treatment of parathyroidism seems to be surgery. All other measures, such as irradiated ergosterol, other vitamines, light, calcium, *etc.*, do not affect this type of parathyroidism. The deficiency type, however, such as rickets and osteomalacia, especially those following pregnancy, are usually treated by these medical means. Surgical technic should endeavor to remove at least two bodies. The two inferior ones seem to be the most easily found. The branch of the inferior artery should be carefully ligated. The nerve can be seen, and keeping the patient fairly well awake during the excision will allow watching respiration and phonation and prevent injury to the nerve.

*Summary.*—In summing up, parathyroidism in its well-developed form, is easily recognized. We should, however, make the diagnosis on the earlier stages of the condition by paying more attention to the calcium examination of the blood and the Roentgen-ray examination of the spine for demineralization and deformities of the vertebral bodies. Metastastic calcifications should be included in the symptoms, as they are very frequent and very likely contribute to certain ankylotic types of arthritis. Parathyroidectomy with proper protection of the patient over the post-operative period with small doses of parathormone seems to be a fairly safe procedure.

DISCUSSION.—DR. WALLACE I. TERRY (San Francisco, California) spoke of the electro knife, which saved good thyroid, which forms a shell of adenomas and thereby saves the parathyroids and preserves intact the laryngeal nerves.

This shell-out method—considered from the standpoint of carcinoma—is the type of operation that they had been doing, particularly since a work on parathyroids that was done in his (*Terry*) clinic, the occurrence of parathyroids on the anterior portion of the thyroid. It is surprising—in 10 per cent. of the cadavers one or more of the parathyroids is on the anterior portion. Doctor Tinker, by his technic, saves those, and the speaker was sure that he does the same operation for the non-malignant as for the malignant.

Doctor Terry started in with the electro knife some years ago, but he did not have the persistence of Doctor Tinker. The machine was not a particularly good one; they did not have the right changes in the electric current; they did not have anybody that understood it thoroughly enough to make the proper changes in the current so that one could get the coagulation or cutting effect. But since Doctor Tinker's paper on a similar subject came out some time ago Doctor Searles began using it for the coagulation of the vessels outside the muscles under the skin flap, although he hasn't as yet used it in the gland itself.

The speaker did that in one case recently with quite a degree of satisfaction. It did away with the ligatures necessary externally and shortened the time of operation. But with Doctor Tinker's experience, and his advice, he will try the knife on the gland itself, because he felt that his bad results have been due to bad currents and poor technic on their part.

Dr. HARRY H. KERR (Washington, D. C.) discussed Doctor Naffziger's paper on persisting and progressive exophthalmos. He said that no one has proved why exophthalmos occurs in exophthalmic goitre, nor has anyone proved what produces it. Further than that, the progressive type that continues even after thyroidectomy has never been adequately explained. This case shows a very striking result, and we believe we now have some actual data that will perhaps solve this very interesting problem.

Doctor Naffziger's experience is also fascinating in the speculation that it stimulates as to other factors in the question of involvement of the optic nerve. There has never been a complete and satisfactory exposition of choked disc. One usually accepts the theory that increased intra-cranial pressure affects the optic disc by the pressure of the cerebrospinal fluid around the nerve in the duval envelope. This pressure is transmitted to the central vein of the retina with resultant œdema and choking of the disc. There has never been a complete explanation of choked disc in other conditions without increased intra-cranial pressure. Nor does this theory explain why there is no choking of the disc in cases where there is a definite increase in venous pressure without an increase of the intra-cranial pressure. The first is illustrated by the presence of choked disc in cases of sinus disease, without increased intra-cranial pressure. The second is illustrated by the absence of choked disc in pulsating exophthalmos. In these cases where there is an arterial fistula between the internal carotid artery and the cavernous sinus, the venous pressure is at its highest, and still a choked disc does not occur.

The decompression of the optic nerve and muscles in this case not only cured a persistent and progressive exophthalmos, but has also cured a choked disc. He believed it is a very profound contribution that promises to be of great value in future research.

Dr. LEONARD FREEMAN (Denver, Colorado) discussing the paper by Doctor Ballin on parathyroidectomy called attention to the work of Leriche, of Strasbourg, who has reported, in the French, that he has deliberately removed the parathyroid for scleroderma, a skin disease, basing the operation upon the researches of Poltier. He seemed to demonstrate that scleroderma nearly always expressed—or sometimes expressed—a hypercalcæmia. He removed the parathyroid upon the right side, the lower parathyroid. The result was startling. Within a few days the pathologic condition of the skin subsided; the symptoms all disappeared, as well as the pain. The case was followed up for some length of time, and it seemed to be more or less permanent. He also reports a second case of a similar character.

Dr. RICHARD H. MILLER (Boston, Massachusetts) said that he had operated upon

two cases of parathyroidism within the past few months. They had the symptoms described by Doctor Ballin, with the disease of the bones, high calcium and no phosphorus. In one of those, no tumor could be found. After a very careful search they did see at least a lower parathyroid, and took out the lower one on each side; also a small unusual-looking bit of tissue which turned out to be a persistent thymus. In the second case there was a definite circumscribed tumor, which felt from the outside like an abnormal thyroid. It was as large as an English walnut. It was closely linked with the posterior portion of the thyroid, and it was removed without difficulty. Immediately after the operation the blood began to come back to normal. It is too early, however, to tell what is going to happen to the bone.

When one has a case which presents such symptoms it is justifiable to explore, as it were; to make the routine thyroid dissection and search for a tumor or overgrowth of the thyroid even if it is not felt beforehand. By carrying out that scheme one will be able to benefit quite a few of these cases, rare as they may be.

Dr. David E. Robertson (Toronto, Canada) detailed the case of a girl fourteen years of age in the hospital in Toronto who had a condition that can be described as Paget's disease. She was quite typical in her Roentgen-ray pictures and the general shortening of the long bones. It was observed that there was a small nodule on the front of the thyroid on the left side about the size of a bead. Her blood was steadily increasing in calcium, and it lacked phosphorus. The tumor was removed. This tumor proved to be of pure parathyroid structure. It is too early to speak of the ultimate result, as only three months have elapsed, but her blood chemistry has changed, her pulse is normal and her general conditions is very much improved. They are watching to see whether or not the changes in the end of the bones will continue or whether it will be arrested.

As to the disease known as Paget's disease he had seen, in the last year or so, an increasing number of these cases in Canadian soldiers. The years are passing on, and these men who were then thirty are now forty and fifty. I think one could pick up in their hospital in Toronto somewhere around fifty cases that show a typical picture of Paget's disease. It is information to him that it may be associated with parathyroid secretion. These cases begin to have their symptoms and bone changes, which are very mild, generally when they are about forty years of age. Recently he saw an old gunner who had been in the British army—he is now eighty-two years of age—with well-marked changes in both gums, ears and digits.

Doctor Tinker remarked that people think that because they have a big goitre they surely must have oversecretion of the thyroid, and if the goitre is small that they have hypothyroidism. As a matter of fact, in many instances the growth crowds the normal thyroid tissue they have left and prevents it from functioning normally, and its removal is followed by a restoration of normal function in quite a number of instances.

As regards Doctor Naffziger's paper, in certain instances exophthalmos may be not only a very disfiguring condition, but also it may be quite painful. One of his patients with an exophthalmos, in his earlier experience, he sent to Doctor Kocher, of Berne, Switzerland, who sent her back with the advice that he go into the orbit posteriorly, Kronlein's exposure, in which the surgeon cuts down the side of the face, paralyzing a good part of the facial nerve supply in order to get into the back of the orbit. Kocher improved the incision quite a lot, and by a little study in our anatomic laboratory Doctor Tinker improved it still more. He went into the orbit, exposed the posterior surface of the eyeball and the optic nerve, and found on it a hæmangioma. This woman was relieved of the pain of her exophthalmos.

He mentioned this because it was apparent to him—and he had been looking for other cases of that kind— that in certain instances exophthalmos may be caused by a tumor pressing upon the posterior surface of the eyeball.

Dr. Plinn F. Morse (Detroit, Michigan) exhibited a series of lantern slides showing parathyroid changes.

# RESECTION OF THE CÆCUM

By Frederic N. G. Starr, M.B., C.B.E.

of Toronto, Canada

Looking back over some forty-five years, one cannot help but be impressed with the strides that have been made in gastro-intestinal surgery during that period. It was only a few years before that time that a surgeon was brave enough to attempt reparative, or even relief, operations upon the gastro-intestinal tract. In fact, in those earlier years abdominal surgery was confined largely to the removal of large tumors of the uterus, and of large ovarian cysts. Rarely was any operation done upon the intestines, except for large bowel obstruction, which consisted mostly of colostomy, and this was done through the loin.

It is true that in 1837, Egebert, a Norwegian military surgeon, read a paper on gastrostomy at the Christiana Medical Society.

It is reported by Marshall that Reybard, of Lyons, performed the first resection of the colon in 1844, but the paper was rejected for publication "because of some want of definiteness."

In 1878 Baum, of Dantzic, removed a growth from the ascending colon, but fæces escaped and the patient died on the seventh day.

In 1878 Martin, of Hamburg, successfully removed the sigmoid.

Of course every little while resections of gangrenous bowel in hernias were done with varying success. Then as technic improved, intestinal surgery advanced by leaps and bounds. The Mayo-Robson bobbin, the Senn decalcified bone-plates, and the ingenious button devised by John B. Murphy, all assisted in showing the way to make these more safe.

In my earlier resections I resorted to the Murphy button until one ulcerated into the peritoneal cavity. Then I turned to the lateral anastomosis. These were most satisfactory and gave very little anxiety during their convalescence. In the meantime the röntgen ray was discovered and some of these patients began to drift back complaining of indefinite discomfort; upon examination sometimes one could discover a mass. Upon X-ray examination it was found that a large pocket had formed at the blind ends of the bowel, in which fæces accumulated.

I then decided to resort to the end-to-end anastomosis, but there was trouble in about one in four of these because of the œdema that took place at the line of suture, giving rise to a temporary obstruction, and a fæcal fistula would form before the œdema could subside. In 1920 I began to use a piece of rubber tube incorporated at the site of the anastomosis,[5] which maintains a lumen through the anastomosis until the œdema subsides. Since this there have been no fæcal fistulæ, and the convalescence has been comfortable and satisfactory with no untoward signs of obstruction.

610

The abdomen is opened through a right rectus incision. The triangular band on the outer leaf of the posterior parietal peritoneum is divided, which permits the cæcum and terminal ileum to be lifted into the wound. The mesentery of the terminal ileum is then punctured and clamped between two pairs of Kocher forceps, and cut. The clamping and cutting is continued until the point selected for resecting the colon is reached. Intestinal clamps are then applied and the colon and ileum are cut across with the cautery knife, the surrounding wound having been carefully protected with gauze packs. No. 2 plain catgut, threaded on a round curved needle, is then secured above the end of the Kocher forceps nearest the divided end of the colon, and the forceps oversewn. The forceps is then withdrawn and the suture pulled tightly. Each forceps is dealt with in the same way until the last one close to the ileum has been removed. With the tightening of this suture as one goes along, and the final tying of it, leaving the ends long, the two open ends of the bowel to be anastomosed will then be found to be lying side by side. Before removing the crushing clamps, the first row of anastomosing suture is applied. Protective clamps are then applied to the bowel about two or three inches from the open ends to prevent leakage, the crushing clamps removed, and the interior of the bowel is wiped clean. The second row of posterior suture is applied, taking in the whole thickness of the bowel up to the anti-mesenteric border. If necessary, the open end of the ileum having been enlarged to fit the colon, as suggested by Balfour, a piece of rubber tubing with a small hole in the centre is then threaded on this suture, and the first row of the anterior suture is then completed. This suture has fixed the tubing in the bowel at the point of anastomosis. The anterior peritoneal suture is then completed, and when this is done the long end of the mesenteric suture is tied to the peritoneal suture, when one finds there is no opening in the mesentery to be closed.

The rubber tubing permits gas to find its way through the anastomosis, and there is no distention in the course of the convalescence. The tube passes per rectum in from five to seventeen days.

We have been using this method since 1920, and have found it most satisfactory. We have done 119 resections for various conditions; eighteen of these were for carcinoma, with eight deaths due to asthenia from the toxæmia of cancer, owing to a delayed diagnosis. Perhaps had we done a preliminary ileostomy, we might have saved more of these. Of the other 101 cases done for tubercle, volvulus, atony with melanosis in the submucosa, *etc.*, there were five deaths. Two were done in insane women, who tore their dressings to pieces and infected their wounds, from which they died. One was a very bad risk, suffering from severe myocardial disease, from which she died two days after the operation. One died of pulmonary embolus, and one from post-operative pneumonia. None of these post-operative cases developed a fæcal fistula, and none died as a direct result of the resection of the bowel, giving us ninety-six cases without any operative mortality.

# SURGICAL TREATMENT OF TUBERCULOMA OF THE CÆCUM

## By Harry Hyland Kerr, M.D.

of Washington, D. C.

Tuberculosis usually affects the intestinal canal as an ulcerative enteritis. In this form it accompanies general tuberculosis, and is found in about 50 per cent. of autopsies of cases dying from tuberculosis.

The intestinal canal is occasionally infected by the tubercle bacillus without invading any other tissues of the body. Such isolated infections produce the neoplastic type of intestinal tuberculosis known as hyperplastic ileocæcal tuberculosis of tuberculoma of the cæcum.

Tuberculoma of the cæcum is most commonly found in young adults. The youngest of my five cases was fifteen, the oldest twenty-eight.

In the early stages it is usually diagnosed as appendicitis. Later, when the tumor formation has occurred or obstruction supervened, it is often mistaken for cancer. The X-ray examination is characteristic. There is a filling defect of the cæcum at the site of a mildly tender mass.

As the disease progresses it tends to interfere with bowel function, and acute obstruction may occur.

The treatment is surgical. Good results have been reported after heliotherapy. In one of my cases a clinical cure resulted after two years of sanitarium treatment. In another, there was little response to light therapy in a year and surgery had to be resorted to because of acute obstruction.

As bowel function is impaired by the lesion, overfeeding—that sheet anchor of tuberculosis—therapy is impossible.

If the tuberculoma can be removed without undue risk and the function of the intestinal canal restored, surgery would seem to be the quickest, most radical, and most economical treatment.

Resection of the tuberculoma by the basting-stitch technic should carry little or no mortality and should result in complete cure. I have seen five cases of tuberculoma of the cæcum, four of which have had their lesions radically removed by the basting-stitch technic without mortality and with complete relief.

The author then presented a moving picture which illustrated a resection of the cæcum and ascending colon for tuberculoma performed six weeks after an ileocolostomy had been established for acute obstruction.

The picture, taken by Dr. Daniel L. Borden at the Garfield Memorial Hospital of Washington, D. C., presented the following:

The tuberculoma of the cæcum is mobilized and lifted from the posterior abdominal wall with its mesentery and glands.

The dilated ileum and relatively collapsed transverse colon are apposed and the sites are selected for resection.

A pair of crushing clamps is applied at right angles to the bowel axis in as close approximation as possible: one pair on the ileum; one pair on the transverse colon.

The bowel is divided between each pair of clamps by the cautery which destroys any tissue remaining between the crushed clamps.

The basting stitch is now applied. A stout linen suture is used in a curved round needle. The basting stitch consists essentially of a continuous suture, without knots, to temporarily close the intestinal incision, a separate suture being used for each of the bowel ends. On account of their method of application and temporary purpose they serve, they bear a certain likeness to the "basting" stitches of the seamstress, and for convenience we have called them by that name.

The first and last bites of the basting stitch are placed parallel to the axis of the bowel. The intervening bites are placed parallel to the crushing clamp *across* the axis of the bowel with the loops between the stitches crossing over the clamps.

The crushing clamps are withdrawn from beneath the loops of the basting stitches. The basting stitches are then drawn taut, invaginating the complete bowel circumference, and producing peritonization of the entire stoma. The mesenteric defect is obliterated by this invagination.

The closed bowel ends to be anastamosed are swung on their respective basting stitches in apposition, ready for suture. A single anastamosing suture is all that is necessary. Single O chromic catgut is used on an eyeless needle.

When the anastamosis has been completed, the basting stitches are cut close to the bowel, one at the mesenteric border, and the other at the free border. The basting stitches are withdrawn.

The bowel wall is then invaginated through the stroma to break up the agglutination caused by the crushing clamps and the cautery.

The mesenteric defect is closed with a running catgut suture. The wound is closed in the usual manner with catgut in the peritoneum, chromic catgut in the rectus sheath, fine catgut in the subcutaneous fascia and silkworm gut in the skin.

The patient made a satisfactory recovery and was discharged from the hospital at the end of two weeks. She was able to return to school within a couple of months and has continued in perfect health ever since operation, having gained twenty pounds. Recent physical examination reveals no abnormality other than the scar of her laparotomy.

# DIVERTICULITIS OF THE COLON

A REPORT OF 36 CASES FROM THE NEW YORK HOSPITAL

By Francis M. Conway, M.D., and James M. Hitzrot, M.D.

OF NEW YORK, N. Y.

FROM THE FIRST SURGICAL (CORNELL) DIVISION OF THE NEW YORK HOSPITAL

IN A discussion of the subject of diverticulitis of the colon, it has been customary to define exactly what one means by the term "diverticulitis." Many have taken care, and correctly so, to distinguish the congenital or true type of diverticulum, as represented by the Meckel's type of diverticulum, from the false or acquired type of gut-pocketing which is the result of a mucosal herniation through the coats of the gut wall. It has impressed the authors that in many of the reviews of the subject, the relationship of "diverticulitis" to the antecedent and practically symptomless "diverticulosis" of the colon has not received enough stress, and that the generalized character of the disease has not been completely emphasized. The observation that there exists in certain individuals, and in the major portion of these types during a certain decade of their life cycle, this tendency to mucosal herniation of the intestinal wall is rather significant. By the generalized character of the disease is meant that although one may find only a diverticulitis in the sigmoid colon, there is usually an associated and accompanying diverticulosis in other regions. Before defining the term, an elaboration of the etiologic factors underlying the condition is advisable for a more comprehensive understanding of it.

*Etiology.*—The actual method of origin of these gut out-pocketings is not understood, although many explanations have been advanced for their presence. They are not congenital in character, as they have been seen to develop through all stages and at a more or less constant time in life, *i.e.*, in the fourth to the sixth decade. Certain factors are offered as being of some significance:

*Age.*—The age at which these gut-pocketings are seen is most commonly between the ages of forty and sixty. Telling,[11] in his series of sixty cases found the average age to be sixty, while in our series of thirty-six cases, the average age was fifty years. The youngest case in our series was found in an individual of thirty and the oldest in a patient of sixty-seven.

*Sex.*—In most series, the incidence is taken to be two to one for males as compared with females. However, Newton,[10] in his report of forty cases found it to be almost one to one, and in our listing of thirty-six cases, there were eighteen males and eighteen females.

*Obesity.*—Most of the cases seen were usually in well-nourished persons who were slightly overweight.

*Constipation.*—Constipation and flatulence have long been held as prime

agents in the production of diverticula; the idea being expressed, that an increase in intracolonic pressure in a slightly atonic large intestine might well exert sufficient force to cause out-pocketings along the lines of least resistance. The normal structure of the bowel wall will lend itself to out-pocketings and especially at the places where the blood and lymph vessels pierce the wall. The adherents of this idea believe that the diverticula are simple pulsion pouches formed as a result of internal pressure at weak points of the bowel. Spriggs and Marxer[13] postulate three stages in the formation of diverticula. They describe first, a pre-diverticular stage which is associated with some weakening of the submucous and muscular layers and the formation of minute pulsion diverticula between the muscle fibres. It is these minute herniations which later form diverticula. Radiologically, in this stage there is a loss of normal segmentation and a more rigid outline with small convexities on it. Microscopically, there seems to be a rarefying of the bowel muscle in the diverticulous areas.

In many cases, there are no symptoms in this stage, especially if only small areas are affected and the inflammation seems to creep along the intestinal wall. Following this they describe a stage of irritation and the stage of developed diverticula. It must be mentioned that up to this point we are dealing essentially with the mechanism of the production of diverticulosis from which we pass to the final stage of the process, the stage of diverticulitis, where inflammatory processes arise around the necks of the pouches, particularly those containing fecoliths, and spread to the wall of the bowel giving rise to a local colitis and pericolitis.

Diverticulitis is, therefore, the final stage of diverticulosis where the small pouches, as already described, become involved and destroyed in the chronic inflammatory process which in the first place arose in themselves. These stages may be all present at once in different parts of the bowel or even in the same segment. Secondary inflammation of the pouches may occur at an early stage and produce dense fibrosis. It may not occur at all or only very late in the development of the diverticula. Finally, Spriggs, in arguing for a stage of irritation or inflammation in the development of diverticulitis points out that in his experience there is nearly always a focus of sepsis present elsewhere in the body such as abscessed teeth, chronic cholecystitis, arthritis, etc. In so far as the diverticulitis is the result of inflammation spreading to the bowel wall from pre-existing diverticula (the retained content of which has become septic), the etiology is clear. It is the formation of the diverticulosis which is disputed.

*Pathology.*—The pathologic features are those of a chronic inflammation of the bowel wall, arising at first from one or more diverticula but later involving all the coats of the intestine including sooner or later the peritoneal coat and later spreading to the surrounding structures. In 1849 Cruveilhier[1] described the sacculations and their anatomic relationships while Virchow in 1853[2] gave a minute description of the peridiverticulitis which he referred to as a "chronic adhesive peritonitis." Habershon[25] in 1857 in a monograph

on diseases of the alimentary canal reported a series of cases with some pathologic findings including some of the complications of the condition. Klebs[26] in 1869 was among the first to recognize the origin of the condition in the diverticula.

Grossly, the pouches look like pea-shaped projections from the bowel. These may be contained in the appendices epiploicæ or are covered with fat and are not visible. Inasmuch as they frequently tend to grow into the appendices epiploicæ, they are most difficult to distinguish in situ and all that one sees is a tuberous-like appearance of the bowel. When, however, the fat is stripped off, the diverticula are seen as typically bottle-shaped out-pocketings, dark blue in color. The characteristic dark blue color is due to the fact that the mucosa and submucosa have herniated through the muscle wall and the contained fecoliths are seen through this wall. Usually a thin



Fig. 1.                                   Fig. 2.

Fig. 1.—Pathologic specimen No. 21,470. Section shows a typical herniation of the mucosa through the muscularis and the formation of a diverticulum. Section, in addition, shows a portion of the mucosa with evidences of a catarrhal inflammation; round-cell infiltration of the submucosa, muscularis and adjacent fat tissue. Specimen removed at operation from Case XXXI. Chronic perforative diverticulitis of the descending colon with abscess.
Fig. 2.—Pathologic specimen No. 19,727. Section represents diverticulum wall, showing it to be lined with granulation tissue that is infiltrated with numerous plasma round cells, eosinophiles and many polynuclear leucocytes. The submucosa shows similar inflammatory changes. Specimen removed at operation from Case XXX. Chronic diverticulitis with pericolitis and stenosis.

strip, whitish in color, can be made out about the neck of the diverticulum, marking the limit of the muscle covering.

Microscopically, there is a rarefying of the bowel muscle in the diverticulous areas and in many sections (viz. Fig. 1) the mucosa and submucosa may be seen penetrating the coats of the intestinal wall. Following the development of the pericolitis, as the process continues, abscesses and fistulæ are formed. The sites of spread are commonly to the bladder, small intestines, and abdominal wall in the male while in the female, in addition to these, the adnexæ and uterus are frequently involved. As the chronic inflammation continues, it leads to a fibrous thickening of the gut wall with resultant stenosis of the bowel with a wall from one-half to one inch in thickness. Accordingly, it may be seen that the attack of diverticulitis with threatened obstruction may occur as the result of two conditions which differ widely

in their ultimate gravity. The first type is where there is an attack of acute diverticulitis with the mucosal folds of the intestine inflamed and œdematous but without any implication of the other coats of the bowel. The second type is that in which there is a fibrous constriction of the bowel wall. In this type the mucosal swelling is at a minimum, with the bowel rigid, and the danger from obstruction is greater. It is in this state, when the constriction becomes quite narrowed, that chronic dilatation of the gut above the point of stenosis may be noted.

*Symptoms.*—The varying clinic manifestations of the disease will depend entirely upon the stage of the disease and its extent. Diverticula, of themselves, cause no trouble, but the facts of their physiology and anatomy lead one to expect inflammatory changes in them. Their presence without symptoms of any kind is proven by the fact that they are often seen in many routine barium enema examinations. As a rule, there is a certain amount of abdominal discomfort, less often pain, and not as a rule related to the ingestion of food. Since the greater portion of the lesions were found in the sigmoid, the pain and discomfort was situated about or below the umbilicus, but more often in the left lower quadrant of the abdomen. Intervals of apparent quiescence are a common finding. With an understanding of the pathology, these facts become quite evident. Flatulence and a feeling of distension may be the only symptoms, and in many an advanced stage of the disease may be reached before any deviation from the normal is noted. It is for this reason that in individuals of this age-group any change from the normal bowel habit should warrant a complete investigation which should include a radiographic examination of the intestinal tract.

Constipation, diarrhœa, or a sense of incomplete evacuation are frequent, increasing constriction thus leading slowly to signs of obstruction. Urinary frequency or discomfort is common when a loop of gut is plastered on to the bladder. There may be a story of disability for years, though Newton found that a two-year past history was about the average. In the acute perforative cases, there is usually no history until shortly before admission to the hospital. The existence of a palpable mass, with its usual location in the left lower abdominal quadrant, is a common finding with such complications as perforation with abscess and infiltration of the bowel wall. Hæmorrhage by rectum is not common, as the inflammatory lesion lies as a rule outside of the mucous membrane in the form of a peridiverticulitis. With the onset of the acute condition, and more especially, when there is perforation, the differential diagnosis becomes increasingly more difficult. As a rule, loss of weight is not characteristic, for most of the patients are usually of the slightly overweight type. In our series of thirty-six cases the symptoms and signs in order of their frequency were: pain across the lower abdomen, usually more pronounced in the left lower quadrant, constipation, flatulence, nausea, palpable tumor, diarrhœa, melæna, and urinary frequency.

*Diagnosis.*—The varying picture makes the diagnosis depend on competent radiographic examination of the large intestine, and radiologically the

picture is fairly characteristic. In the early stages, before stenosis has completely distorted the appearance, there are spiked or palisade-like projections of the barium shadows from the lumen of the bowel, the wall of which is thickened from the inflammatory exudate and fixed. This appearance is caused by the deformity and contracture of the haustra. The other picture with the bleb-like deposits of the barium in the actual diverticula is well known. As regards the location of the diverticula, although they are found throughout the colon, the commonest site is in the sigmoid. The following table shows the distribution in various series:

| Series | Sigmoid | Sigmoid and Pelvic | Descend. Colon | Descend. and Sigmoid | Transverse | Ascend. Colon | Entire Colon | Appendix | Caecum | Rectum |
|---|---|---|---|---|---|---|---|---|---|---|
| Newton 44 cases............ | 25 | | 12 | | 1 | 8 | | | 1 | |
| Spriggs and Marxer 166 cases.......... | | 120 | 79 | | 33 | 33 | 24 | 6 | 8 | 4 |
| New York Hospital 36 cases............ | 17 | | 3 | 10 | 1 | 2 | 1 | | 1 | |
| Lockhardt Mummery 41 cases............ | 36 | | | | 3 | 1 | | | 1 | |

*Classification.*—An attempt has been made to group the cases in this series after a schema used by Monsarrat which seemed to be as lucid and complete as any encountered. They are as follows:

(1) Acute diverticulitis without perforation or complication. (2) Chronic diverticulitis without perforation or complication. (3) Acute perforative diverticulitis with peritonitis. (4) Chronic perforative diverticulitis with complication such as abscess or fistula formation. It is to be realized that there is no sharp differential diagnosis existent between groups 3 and 4. Group 4 forms the largest group and within it are those cases of "pericolitis sinistra" and cases where no single perforation was demonstrable. (5) Diverticulitis with stenosis. (6) Diverticulitis with coincident carcinoma.

In Group 1 have been placed those cases where there is an inflammation of the mucosal folds with an inflammation of one or more diverticula followed by subsidence of the attack without any complication. In Group 2 have been placed those cases where there has been a vague history of flatulence, constipation, and where radiographic plates or subsequent laparotomy have revealed the presence of diverticula but without any complicating condition.

In Group 3 have been placed those cases of perforative diverticulitis with peritonitis where the first symptom of the condition was, in many cases, the symptomatology following their generalized peritonitis. This group merges gradually into the next class Group 4.

In Group 4 have been placed those cases with complicating factors such as abscess, secondary involvement of other viscera, and fistula formation.

Here also have been placed those cases in which there has been any appreciable amount of pericolitis with subsequent adherence to the surrounding structures.

Group 5 is self-explanatory, though in passing, it might be mentioned that it is often the late stage of Group 1.

Group 6 has been included merely for the sake of completeness. It is in this group that new growths are said to occur in, on, or in association with diverticulitis. This group we believe to be open to question and in fact, two cases which were originally classed as diverticulitis and later turned out to be carcinoma are not included in this series. In one of these cases a revision of the microscopic sections revealed the presence of tumor cells which had been overlooked at the time it was first reported.

*Complications.*—The possibilities of complication with diverticulitis of the colon are without end. The commonest of all is abscess formation with subsequent involvement of the surrounding structures. In one of our cases in this series, Case VIII, the tube and ovary were so involved in the inflammatory process as to warrant their removal. Vesicocolic fistulæ with the attendant pneumaturia and the passage of gas and fecal material per urethram have been reported. Stricture of the sigmoid follows quite naturally upon the pathologic process involving that part. Less commonly, emphysema of the scrotum following a perforation of the sigmoidal diverticulitis has been noted.

*Treatment.*—The treatment will vary with the individual case and with the conditions existent when the case is first seen. It will depend essentially on the type of the disease, the extent of the colonic involvement and the condition of the individual. It should be stated here that diverticulitis is not primarily a surgical entity; that surgical treatment is indicated only for the complications of the disease such as perforation, abscess, obstruction and fistula formation.

It has been stated that as the knowledge of the disease increases, less surgery will be employed. Diverticulitis is a complaint that can be controlled if it is recognized early and treated by appropriate methods. When complications arise, the disease assumes a more disabling character and the treatment is not so simple as in the uncomplicated cases. The mortality may be high in cases of perforation accompanied by peritonitis, as is to be expected. With Type I acute diverticulitis without perforation, cæcostomy or colostomy have been recommended with the idea that the acute stage will subside more rapidly with a divergence of the fecal stream. It would seem to us that a greater number of cases may be treated expectantly with better results. In the series presented in this article, four cases have been classified in that category. On one of these, Case XXVI, an exploratory laparotomy was performed and the appendix removed in course; the other three cases were treated conservatively and improved under that form of therapy. With Type II, referred to as chronic diverticulitis without complication or perforation, the treatment is non-surgical. In this group all of the cases

were treated conservatively with the exception of one case, Case XXXII, which was discharged from the hospital as unimproved.

The non-surgical treatment which is the same for an early case of diverticulitis as that of diverticulosis, consists in keeping the body, the alimentary canal, and especially the mouth and colon as healthy and clean as possible. Any source of sepsis that can be reached must be removed. (Spriggs.) The diet should be simple and regular, with a good deal of fruit and vegetables and little meat. Meat may be given two or three times a week to begin with, but later added daily, if desired, providing that regular bowel movements are established. If there is such a degree of inflammation of the mucous membrane as to make it undesirable to give fruit, greens or whole wheat bread, an entirely non-irritating or bland diet of cereals, milk or fish is needed. Altering the intestinal flora by vegetable foods and *Bacillus Acidophilus* in milk also seems to do some good. In addition, milk sugar is given as a pabulum for the *B. Acidophilus.* The use of mineral oil in amounts sufficient to insure the soft character of the bowel movements is of utmost importance.

With Types III and IV the question of therapy is determined by the individual case, as may be seen by the various procedures performed on the cases placed in these groups. It is in this sub-division that the question of treatment is distinctly surgical in character.

With Type V, the question of resection in the presence of sub-acute obstruction is another point of dispute, as some are of the opinion that resection should be prefaced by a long trial of medical therapy, and that if the bowel is becoming more and more constricted, preliminary cæcostomy or colostomy above the point of stenosis should be considered.

## CONCLUSIONS

1. Diverticulitis of the colon, by virtue of its intrinsic pathology will produce a variety of symptoms.

2. Although the majority of the cases show involvement of the sigmoid, the condition is not limited to that region.

3. The actual method of production of these mucosal herniations is unknown, although two methods of possible formation are considered.

4. Diverticulosis of the colon, being a precursor of the condition, is not to be regarded lightly, and vague gastrointestinal upsets and attacks of flatulence in adults between the ages of forty and sixty warrant further investigation, which should include a barium series.

5. Diverticulitis is the final stage of diverticulosis where the small pouches become involved and destroyed in the chronic inflammatory process, which in the first place arose in themselves.

6. In this series, the symptoms in order of their frequency were: Pain across the lower abdomen usually more pronounced in the left lower quadrant; constipation; flatulence; nausea; palpable tumor mass; diarrhœa; melæna and urinary urgency.

7. The gross and microscopic pictures are fairly characteristic, and demonstrate quite readily the reason for the symptomatology.

8. Various stages of the disease have been noted, all of which may be present at the same time in the same segment, or in different parts of the bowel.

9. In our series of thirty-six cases, twenty-six required surgical treatment and ten were treated by conservative methods. There were seven deaths, five of the seven being due to the generalized peritonitis present at the time of operation. This would make a mortality rate of slightly less than 27 per cent. for this series, indicating the high mortality in the complications of diverticulitis.

10. Complications are manifold and include peritonitis, abscess formation, fistula formation and stenosis of the bowel.

11. The disease is essentially a non-surgical entity, surgery being employed mainly in the treatment of the complications.

TABLE I

*Group "A"—Acute Diverticulitis without Complication or Perforation*
(Four Cases)

| Group | Location of Lesion | Duration of Symptoms | Treatment | Result |
|---|---|---|---|---|

(1) Descending and sigmoid, 3 days. Exploratory laparotomy, appendectomy (No. 26). Improved.

(2) Descending and sigmoid, 2 months. Conservative, dietary (No. 25). Improved.

(3) Descending and sigmoid, 14 hours. Conservative, dietary (No. 24). Improved.

(4) Descending and sigmoid, 7 days. Conservative, dietary (No. 10). Improved.

*Group "B"—Chronic Diverticulitis without Perforation or Complication*
(Seven Cases)

(1) Descending and left transverse, 12 months. Conservative, dietary (No. 23). Improved.

(2) Sigmoid. Conservative, dietary (No. 27). Improved.

(3) Descending. Conservative, dietary (No. 28). Improved.

(4) Sigmoid, 8 years. Conservative, dietary (No. 29). Improved.

(5) Descending and sigmoid. Conservative, dietary (No. 32). Unimproved.

(6) Sigmoid and Descending, 5 years. Conservative, dietary (No. 34). Improved.

(7) Ascending colon, 4 weeks. Conservative, dietary (No. 35). Improved.

*Group "C"\*—Acute Perforative Diverticulitis with Peritonitis*
(Nine Cases)

(1) Sigmoid, 5 days. Witzel enterostomy; appendectomy (No. 22). Died (general peritonitis; ileus).

(2) Sigmoid, 2 days. Excision of diverticulum with drainage (No. 19). Improved.

(3) Sigmoid, 3 days. Cæcostomy; incision and drainage of sigmoidal abscess (No. 18). Died (general peritonitis).

---

\* There is no sharp differential diagnosis existent between Groups C and D. Group D forms the largest group, and within it are those cases of "pericolitis sinistra" and cases where no single perforation was demonstrable.

TABLE I—(*Continued*)

(4) Sigmoid, 2 days. Biopsy and Miculicz' tampon drain (No. 13). Died (general peritonitis).

(5) Sigmoid, 1 month. Miculicz' operation (first stage) (No. 4). Died (general peritonitis).

(6) Cæcum, ascending and right transverse, 5 days. Resection of ascending colon and hepatic flexure (hemicolectomy) (No. 11). Died (pneumonia).

(7) Cæcum, 2 days. Suture of perforation without drainage (No. 3). Died (general peritonitis).

(8) Cæcum, 2 days. Excision of diverticula without drainage (No. 2). Improved.

(9) Sigmoid, 2 to 3 weeks. Miculicz' operation (first, second and third stages) (No. 1). Improved.

*Group "D"\*—Chronic Perforative Diverticulitis with Abscess*
(Fourteen Cases)

(1) Sigmoid, 2 years. Laparotomy; incision and drainage of abscess (No. 33). Improved.

(2) Descending. Excision of diverticulum with drainage (No. 31). Improved.

(3) Sigmoid and descending, 10 days. Laparotomy; biopsy (No. 21). Improved.

(4) Sigmoid, 2 years. (*a*) Incision and drainage of abscess (August, 1927). (*b*) Excision of fistulous tract with drainage of abscess site (June, 1928). (*c*) Closure of fecal fistula (June, 1928) (No. 20). Died (bronchopneumonia).

(5) Sigmoid, 3 days. Incision and drainage of abscess; Miculicz' tampon drain to site (No. 17). Improved.

(6) Sigmoid, 1 day. Resection of sigmoid with an end-to-end anastomosis (No. 16). Improved.

(7) Descending and sigmoid, 5 days. Excision of diverticulum (No. 15). Improved.

(8) Ascending colon, 5 weeks. Miculicz' operation (first, second and third stages) (No. 14). Improved.

(9) Descending, 2 weeks. Incision and drainage (No. 9). Improved.

(10) Sigmoid, 3 months. Miculicz' operation (first, second and third stages); left salpingo-oöphorectomy (No. 8). Improved.

(11) Sigmoid, 6 months. Partial resection with drainage (No. 7). Improved.

(12) Sigmoid, 3 months. Incision and drainage, Miculicz' tampon drain (No. 6). Improved.

(13) Sigmoid, 2 to 3 months. Miculicz' operation (first, second and third stages) (No. 5). Improved.

(14) Sigmoid, 2 weeks. Miculicz' operation (first, second and third stages) (No. 36). Improved.

*Group "E"—Diverticulitis with Stenosis*
(Two Cases)

(1) Sigmoid, 2½ years. Resection of sigmoid with drainage (No. 30). Improved.

(2) Descending and sigmoid, 3 weeks. Conservative, dietary (No. 12). Improved.

CASE RECORDS

CASE I.—A. M., male, fifty-one years of age, was admitted to the hospital for the first time February 21, 1930, with the complaint of dull dragging pain in the lower left quadrant, in the region of the sigmoid, of some two to three weeks' duration. The pain had remained localized to that area and did not radiate, but was accompanied by some nausea. He had not vomited, nor did he relate the pain in any way to the ingestion of

---

* There is no sharp differential diagnosis existent between Groups C and D. Group D forms the largest group, and within it are those cases of "pericolitis sinistra" and cases where no single perforation was demonstrable.

food or to bowel movements. There was no history of constipation. He was a well-developed man; well-nourished and not appearing acutely or chronically ill. Examination was quite negative, except for tenderness in the left lower abdominal quadrant and the sensation of a globular mass in the region of the sigmoid. Past history negative, except for an appendectomy performed in 1901 and for chronic sinusitis, for which he had been receiving treatment. Laboratory findings, negative.

*Course in hospital.*—With rest in bed, regulated dietary régime and enemata, the pain in his left lower quadrant subsided and he was allowed home on February 26, 1930. Two days after his discharge from the hospital, he was stricken with a pain in his left lower quadrant, severe enough to keep him awake the entire night and to make him nauseated. He did not vomit and was not constipated. Re-admitted to the hospital March 5, 1930, and a laparotomy performed five days later.

Operation revealed diverticulitis of the recto-sigmoid junction, with that portion of the bowel covered with omentum and adherent to the abdominal wall. On separating on the tissues, a perforation of the diverticulum was clearly seen. A first-stage Miculicz operation was performed and the second stage completed five days later. His post-operative course was entirely satisfactory, and he was allowed home on the thirty-eighth day after operation with his wound still draining a small amount. He was to return at a later date for the closure of the fistula. (Third stage of the Miculicz.) He returned July 21, 1930, for the closure of his wound and was discharged on August 14, 1930, with the wound completely healed except for a small sinus at the lower angle of the wound. His general condition at time of discharge was reported as being excellent. He reported again at the follow-up clinic on November 18, 1930, at which time he was reported to be in excellent general health, with his wound entirely healed, and having gained considerable weight.

He was classed in Group C—a case of acute perforative diverticulitis with peridiverticulitis. The pathologic microscopic section taken at the time of the first operation was reported as diverticulitis of the sigmoid with the evidences of acute inflammatory reaction in the surrounding fat tissue. (Path. No. 41, 269.)



FIG. 3.—Diverticulitis of the appendix, showing characteristic herniation of the mucosa through the coats of the intestinal wall. Pathologic specimen No. 43,480. Specimen removed at operation; case not included in this series.

CASE II.—G. R., male, fifty-three years of age, was admitted to the hospital January 25, 1928, with the complaint of generalized lower abdominal pain of two days' duration. At the time of admission the pain had radiated to the right lower quadrant, where it had localized. He felt slightly nauseated but had not vomited and had not been constipated. No melæna. He was well-developed and well-nourished, with some tenderness in the right lower quadrant, with no especial rigidity, no palpable mass present, a negative psoas sign, but with definite rebound tenderness. Laboratory findings, negative.

A pre-operative diagnosis of acute subsiding appendicitis was made, and a laparotomy performed. At operation, the appendix was seen to be mildly injected and not acutely inflamed. There was a mass of firm fat adherent to the lower outer portion of the cæcum. This was dissected free and was found to have surrounded a small diverticulum which had perforated. There were six other diverticula which were located in the same region, varying from one-eighth to three-quarters of an inch in length. The perforated one and the edges of two others were removed with double chromic inversion of the base. The rest of this area, which lay between the two longitudinal muscular bands, was infolded with interrupted chromic sutures.
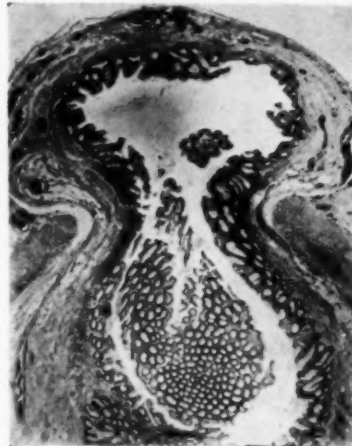
623

His post-operative course was entirely uneventful and he was allowed home on his ninth post-operative day with his wound healed by primary union, and general condition excellent. Discharged February 4, 1928.

The pathologic report of the specimen taken at operation was diverticulitis of the cæcum with evidence of acute inflammatory reaction in the surrounding fat tissue. (Path. No. 37,118.)

He was seen at the follow-up clinic May 4, 1928, three months after his discharge from the hospital, and his condition was reported as being satisfactory, although at times he was said to have an occasional pain in the right side.

He was grouped in Group C—a case of acute perforative diverticulitis with peridiverticulitis.

CASE III.—G. F., male, thirty-two years of age, was admitted to the hospital August 9, 1930, with a two-day history of pain in the right lower quadrant of the abdomen, localized to that area and not radiating. Two days before entering hospital, he was suddenly stricken with a sharp knife-like pain on arising in the morning. The pain continued, always remaining localized. He did not vomit, nor did he feel nauseated. No history of constipation or diarrhœa. No melæna. Had never had any previous attacks. He was a well-nourished and well-developed man, appearing acutely ill, with pain, tenderness and rigidity in the right lower quadrant. There was no palpable mass present. Rectal examination disclosed very definite tenderness in the right rectal wall. There was generalized tenderness all across the entire lower abdomen. Temperature on admission, 101; pulse, 90; white blood-cells, 12,300; polymorphonuclears, 77 per cent.; hæmoglobin, 90 per cent.; urinanalysis, negative.

A pre-operative diagnosis of acute appendicitis was made and a laparotomy was performed. At operation, on opening the peritoneal cavity there was some escape of free fluid and evidence of a mild beginning peritonitis. The appendix was delivered and found not to be acutely inflamed. Appendectomy was performed. Just distal to the ileocæcal valve there was a diverticulum which was perforating and which had been sealed around by a small amount of inflammatory tissue. The diverticulum was closed by a Z-stitch, and a tab of omentum fastened over it. The abdomen was closed without drainage.

His post-operative course was stormy and one of progressive decline. On the morning of his first post-operative day, his temperature was 103; pulse, 114; and respiration, 20; and he was somewhat cyanosed. He seemed to be suffering from a grave toxæmia. In spite of all supportive measures, he expired on the second day after operation. Culture of the fluid taken at time of operation was reported as being *B. proteus.*

*Necropsy findings were*—Diverticulum of cæcum, perforating with an associated acute generalized peritonitis. Microscopic sections were reported as showing an acute hæmorrhagic inflammatory reaction in the wall of the gut. (Path. No. 42,141.)

Case placed in Group C—acute perforative diverticulitis with an accompanying generalized peritonitis.

CASE IV.—J. M., male, forty-five years of age, was admitted to the hospital October 18, 1930, with the history of cramp-like pain of two days' duration over the entire lower abdomen. He stated that for one month prior to his entrance to the hospital he had been more or less constipated. Purgatives seemed to relieve him only temporarily. With the onset of the cramp-like pain, his bowels did not move at all, though he could still pass some gas and did pass both blood and mucus. Has never had any previous attacks or gastro-intestinal upsets of any kind. Past history negative except for hæmorrhoidectomy performed in 1928. He was acutely ill, with pain and tenderness all across the lower abdomen but with no palpable masses or rigidity. Rectal examination disclosed definite tenderness in the left rectal wall. Examination, except for the above and the presence of a bilateral bronchitis, was negative.

Under spinal anæsthesia a laparotomy was performed, and at the junction of the rectum and sigmoid an inflammatory mass was noted. There was evidence that it had been trying to perforate, and there was marked reaction of the peritoneum with an acute localized peritonitis. The mass was delivered and a first-stage Miculicz' operation performed. His post-operative course was one of progressive and rapid decline. He developed signs in his chest which radiographically had the appearance of a root pneumonia. He expired on the sixth day after operation.

*Necropsy findings were*—Acute sigmoid diverticulitis with perforation and an associated acute generalized peritonitis. (Autopsy No. 7,022.)

Case classified as Group C—acute perforative diverticulitis with an accompanying generalized peritonitis.

CASE V.—F. B., male, fifty-two years of age, was admitted to the hospital March 28, 1922, with the complaint of irregular attacks of pain in the left lower abdominal quadrant of three months' duration, with a sharp pain, non-radiating in character in the left lower quadrant for the first time. Since that time he has had several attacks of pain which will come on about three hours after eating, especially if he has over-indulged in food. This attack will last for about three days, during which time he is constipated



FIG. 4.                                FIG. 5.

FIG. 4.—This patient was seen in March, 1922, and a diagnosis of chronic sigmoidal perforative diverticulitis with abscess was made. A laparotomy was performed and a three-stage Miculicz' operation completed. He remained free from symptoms until June 19, 1929, when he was re-admitted to the hospital, at which time these films were taken.

FIG. 5.—The barium enema at this time reveals no sign of obstruction but discloses an extensive diverticulosis of the entire colon. At the twenty-four-hour period barium may be seen filling the diverticula. The constriction mentioned in the first film of the barium enema is at the site of the Miculicz' operation, at which point bowel was excised in 1922. (Junction of the rectum and sigmoid.)

and notes the sensation of something pressing on his bladder. Voiding of urine seems to relieve the pain to a slight degree. He has never vomited. Past history is negative except for cholera in 1886. When admitted there was a slight amount of tenderness in the left lower quadrant and a firm movable mass about three inches in diameter was felt in the region of the sigmoid. Under the X-ray (Fig. 4) the proximal portion of the sigmoid showed a narrowing of its lumen and the distal portion of the sigmoid suggested a diverticulum. Laparotomy performed at operation at the junction of the recto-sigmoid. There was a mass, seemingly inflammatory, markedly adherent to the iliac fascia. Separation leaves behind an inflammatory mass in the iliac fascia. The lesion seems to be mainly in the mesenteric portion justifying the diagnosis of diverticulitis. A first-stage Miculicz' operation was performed (March 29, 1922). Second stage completed five days later (April 3, 1922) and the third stage was completed on May 10, 1922. His post-operative course was entirely satisfactory. He returned to his work and felt perfectly well until June 19, 1929, when he returned to the hospital

40

complaining of pain in the left lower quadrant of his abdomen of five days' duration, and constipation for the same length of time. Cathartics did not seem to relieve the dull ache. He was put to bed and given a colonic irrigation with subsequent relief. A barium enema taken at that time revealed no evidence of obstruction but the colon showed bud-like shadows indicating a condition of diverticulosis. Twenty-four hours later remnants of the barium were seen in these small out-pocketings. He was seen at the follow-up clinic on June 14; 1930, and was reported as being perfectly well. Pathologic diagnosis (Path. No. 27,988) reported specimen obtained as showing pericolitis; chr. mesenteritis; acute inflammatory reaction in the surrounding fat tissue.

This case was grouped in Group D—chronic perforative diverticulitis with abscess.

CASE VI.—N. L., female, fifty-three years of age, was admitted to hospital August 24, 1918, with the complaint of a dull pain that remained localized to the left lower quadrant of abdomen, of three months' duration. She has been constipated more or less for the same length of time and states that the taking of cathartics relieves the discomfort. For the month preceding her admission, the pain was increasing in severity. There was some slight tenderness in the left lower quadrant and the presence of a definitely palpable mass in that area.

*Laparotomy Performed.*—In the left iliac fossa, there was found a mass walled off by many loops of adherent small intestine. On separating some of the loops of gut an abscess was disclosed. A Miculicz' tampon drain was inserted down to the abscess cavity. Her post-operative course was entirely satisfactory though somewhat prolonged. Culture of the pus obtained at time of operation was reported as showing a Gram-negative bacillus and a streptococcus. She was discharged from the hospital October 15, 1918 (fifty-third day after operation).

This case was placed in Group D—chronic perforative diverticulitis with perforation and abscess formation.

CASE VII.—M. C., female, forty-eight years of age, was admitted to the hospital June 22, 1920, with history of intermittent attacks of pain in the left lower quadrant of the abdomen of six months' duration. She stated that for the preceding six months she had had dull pain across her lower abdomen but more especially in the left lower quadrant. The attacks of pain are in no wise related to her menses, ingestion of food, or to bowel movements, but are increasing in frequency and severity. She was obese, not appearing acutely or chronically ill. Examination was quite negative except for some tenderness below the umbilicus and to the left of the mid-line, where, in addition, there was the sensation of a palpable mass.

*Laparotomy Performed.*—At operation there was found to be a large mass in the recto-sigmoid surrounded by a large abscess. The mass was too large to be delivered. A partial resection was performed and drains placed to the abscess cavity.

Pathologic report (Path. No. 23,748) was diverticulitis of the sigmoid with perforation. Grossly, along the course of the gut, a number of diverticula are found. One of these shows a perforation leading into a cavity with ragged hæmorrhagic walls. Microscopically, there is a catarrhal inflammation of the mucosa; a thickening of the musculature and an acute inflammation of the surrounding fat tissue.

Her post-operative course was uneventful but prolonged. She developed a fecal fistula at the site of drainage and was discharged from the hospital on August 24, 1920, with her wound draining. She was seen at the follow-up clinic December 23, 1920, and was reported as being fairly well.

This case was placed in Group D—chronic perforative diverticulitis with abscess.

CASE VIII.—S. P. D., female, thirty-eight years of age, was admitted to the hospital March 15, 1917, with a history of pain and a mass in the left lower quadrant of the abdomen of three months' duration. Three months prior to her entrance, she gave birth to a child and two weeks later was stricken with a pain in the left lower quadrant which seemed to radiate around to the left side and back. Pain is not constant but is of sufficient severity to cause her to take to her bed. She has been constipated for the

same length of time. Examination discloses pain, tenderness and a palpable mass in the left lower quadrant.

*Laparotomy Performed.*—At operation most of the mass felt consisted of inflamed omentum in the left tube and ovary, uterus and sigmoid in the left iliac fossa. The left tube and ovary show evidences of an acute inflammatory process and were removed. Further dissection showed a mass in the sigmoid running to the mesosigmoid, diverticular in character and adherent to a coil of small intestine which was separated without damage. First-stage Miculicz' operation performed on the mass in the sigmoid. Second stage performed five days later.

Her post-operative course was entirely satisfactory; her colostomy wound closed rapidly, but she insisted on leaving the hospital before the third stage of the operation was completed. At that time, however, she was having formed stools and a minimal discharge from the abdominal wound. Her general condition was excellent.

Pathologic report (Path. No. 21,201) stated that the specimen of omentum microscopically showed evidences of a chronic inflammation and that the ovary showed signs of an acute inflammatory process on its peritoneal surface.

Case placed in Group D—chronic perforative diverticulitis with abscess.

CASE IX.—O. P., male, forty-nine years of age, was admitted to the hospital July 7, 1921, with the complaint of pain in the left side of the abdomen associated with pain on defecation of two weeks' duration. Two weeks prior to entrance to hospital he was suddenly seized with a severe pain in the left side of the abdomen; pain disappeared but returned shortly thereafter with increased severity. Onset of the pain in the left upper quadrant with radiation around to the front under left costal margin. He has had to resort to cathartics to relieve constipation and with a movement of bowels pain is lessened. Physical examination is negative except for some tenderness and rigidity in the left upper quadrant.

*Laparotomy Performed.*—Splenic Flexure of colon bound down to the surface of the anterior capsule of the left kidney by rather firm adhesions. As these were separated, an abscess was found and about four ounces of thick, creamy pus were evacuated. There was nothing suggestive of a new growth. A drain was placed to the abscess cavity.

Post-operative course was entirely satisfactory with the wound closing gradually so that at the time of discharge on the thirty-sixth day after operation only a small sinus remained. At the follow-up clinic on November 15, 1921, he was described as an excellent result with no complaints.

This case was placed in Group D—chronic perforative diverticulitis with abscess.

CASE X.—T. F., male, forty-two years of age, admitted to the hospital February 19, 1930, with the complaint of pain across the lower abdomen of one week's duration. Eight days prior to his entrance he was seized with an attack of sharp pain which started in the lower abdomen and gradually spread around to the left side and back. Did not have any relation to the ingestion of food and was not accompanied by any nausea or vomiting. He has not been constipated. He was a well-developed and quite wellnourished man who appeared acutely ill. There was a generalized tenderness across the left side of the abdomen more pronounced in the left lower quadrant of the abdomen.

On radiographic plates the descending and the upper sigmoid colon presented a saw-toothed appearance indicating an early diverticulitis. He was put to bed and placed on a dietary régime which he was advised to continue after discharge. His acute manifestations disappeared and he was discharged from the hospital February 26, 1930.

This case was placed in Group A—acute diverticulitis without perforation or complication.

CASE XI.—J. P., female, forty-four years of age, was admitted to hospital February 15, 1930, with the history of pain in the right lower quadrant of the abdomen of five days' duration. The onset of her complaint is said to go back thirty years (1900), when she declares she had her first attack of pain in that area. Attack lasted for two or three days and then went away. Since that time she has had occasional attacks of

pain in every two or three months and these would sometimes last for two days. The pain is not related to meals, menses or to bowel movements but is increased by any pressure on the right side. The pain has never been intense but has been more of a dragging sensation. There is also a history of flatulence. In the right lower quadrant of the abdomen there are definite pain, tenderness and rigidity. On palpating over McBurney's point, one gets the impression of a globular mass which is fairly movable and tender.

*Laparotomy Performed.*—At operation there was a mass about the size of two fists involving the cæcum and the transverse colon. There seemed to be deposits in the meso. Under the diagnosis of a carcinoma, a resection of the ascending colon and the hepatic flexure was completed. During the dissection the gut was opened and was subsequently found to be a pocket from the perforation of the diverticula in the cæcum which were adherent to the hepatic flexure. Anastomosis was made by lateral anastomosis of the lower ileum to the transverse colon at its mid-portion. Operation performed was a hemicolectomy.

The post-operative course was complicated by a bronchopneumonia from which the



FIG. 6.                                    FIG. 7.

FIG. 6.—Radiographs from Case XII. Chronic diverticulitis with stenosis. Film No. 8,658, taken September 14, 1929, shows a marked constriction at the junction of the descending and sigmoid colon. Constriction is tubular in appearance. There are definite diverticula seen in the descending colon. This patient was treated conservatively with bland dietary measures. Film No. 8,596, taken one year later, after the patient had been under observation for that interval, September 29, 1930, shows no radiographic evidence of diverticula.

FIG. 7.—Radiograph from Case XXV. Acute diverticulitis without perforation or complication. Film No. 5,565, taken June 18, 1930, shows the sigmoid and descending colon to be very spastic and with many bud-like shadows extending from the lumen of the bowel indicating an extensive diverticulitis. The long delay of the barium in the gastro-intestinal series indicates some obstruction. Patient was treated conservatively on the medical division with subsequent diminution of symptoms and improvement.

patient died on the third day after operation. Pathologic report (Path. No. 41,128) was that of diverticulitis of the cæcum, perforating.

This case was placed in Group D—chronic diverticulitis, perforative with abscess.

CASE XII.—L. C., female, sixty-four years of age, was admitted to hospital September 9, 1929, with the complaint of pain in the left lower quadrant of the abdomen accompanied by constipation for the three weeks preceding her entrance. Her history was essentially that of chronic constipation associated with lower abdominal pain and nausea of three weeks' duration. She was somewhat obese and had pain and tenderness in the left lower quadrant of the abdomen. At proctoscopic examination the proctoscope was

stopped at the five-inch level by a constriction of the bowel lumen to one-half its normal diameter. The area was congested but was not ulcerated and the normal bowel mucosa could be seen above the point of constriction. The impression from the radiographic plates and the proctoscopic examination was that of an inflammatory process due to a chronic diverticulitis with perisigmoidal thickening and adhesions. Two or three definite diverticula may be seen in the descending colon (Fig. 6).

Her course in the hospital was entirely satisfactory. She was placed on a bland diet with mineral oil and told to continue on this régime. She was discharged October 10, 1929, to report to the out-patient department for further treatment. This she continued to do up until the time of her second admission, which was on September 24, 1930. At this time her complaint was that of loss of memory and disorientation as to time and place. Psychiatric examination at that time stated that she was afflicted with a non-psychotic vascular aphasic state and that she was liable to have further cerebral difficulty at any time. Radiographs of the colon taken at this time presented no evidence of any diverticula.

This case was placed in Group E—diverticulitis with stenosis.

CASE XIII.—S. L., female, sixty-three years of age, was admitted to the hospital September 17, 1929, with the complaint of pain across the lower abdomen, tenesmus, constipation and abdominal distension of two days' duration. Six days preceding her entrance to the hospital she is said to have swallowed some dentifrice and following this to have had a gastro-intestinal upset. She took a saline purge, which produced several watery stools and cramps. Four days later she was seized with a severe pain in the hypogastrium which is said to have radiated from her navel to her rectum. The latter seizure was accompanied by constipation and abdominal distension. She was acutely ill with generalized tenderness of the entire abdomen and with rigidity more marked in the left lower quadrant.

A laparotomy was done. On opening the abdomen there was found to be a peritonitis in the left lower quadrant which was not walled off. Exploration revealed an abscess about the sigmoid just above the recto-sigmoid junction. A large amount of pus was evacuated. (This was later reported by the bacteriologist as *B. coli.*) A tumor mass was seen about the sigmoid which was not disturbed as the sigmoid did not deliver easily. A small piece of the tumor mass was taken for microscopic section and a large Miculicz' tampon drain was inserted into the abscess cavity. Her post-operative course was one progressive decline; her demise being due to the toxæmia resulting from a generalized peritonitis. She expired on the twelfth day after operation.

Pathologic report of the specimen removed at operation (Path. No. 40,339) was a fibropurulent inflammation in areolar tissue. At the post-mortem examination (autopsy No. 6,837) it was determined that there was a diverticulitis of the sigmoid with perforation of the sigmoid into an abscess cavity and generalized peritonitis.

This case was placed in Group C—acute perforative diverticulitis with peritonitis.

CASE XIV.—J. C., male, thirty-nine years of age, was admitted to the hospital May 9, 1927, with the complaint of pain in the right side, of six weeks' duration. The pain at the onset was dull in character and he continued working for four days until he was forced to take to his bed. He has never felt nauseated and has never vomited, has not been constipated nor has he ever passed any blood in his stools. He states that he has been running a slight temperature since the onset of the condition. The pain has gradually moved upward to the right upper quadrant, where it has remained until the present time. The ingestion of food or change in position do not seem to have any effect. He was acutely ill with pain, tenderness and rigidity in the right upper quadrant. Examination was otherwise negative.

*Laparotomy Performed.*—At operation in the sub-hepatic region, an inflammatory mass involving the colon was found, covered with fibrin and rather firmly attached to the liver. The mass was adherent to the surrounding structures. It was dissected bluntly down to the parietal peritoneum which was many times its normal thickness.

The entire ascending colon and half the transverse colon were freed and brought out of the wound. First-stage Miculicz' operation was done May 9, 1927; second-stage Miculicz' May 12, 1927; and third-stage Miculicz' was completed on his seventy-fourth post-operative day.

His post-operative course was stormy after the completion of the third-stage Miculicz' operation when he developed a pulmonary complication. He was given two transfusions and allowed out of the hospital on the ninety-first day after operation, at which time there was a slight amount of drainage from the lower angle of his wound. He was seen in the follow-up clinic February 2, 1928, when it was reported that his wound was healed, firm and painless and that he had gained weight. He reported again May 16, 1929, and stated that he was working and his condition was declared to be very satisfactory.

This case was placed in Group D—chronic perforative diverticulitis with abscess.

CASE XV.—A. B., female, forty-three years of age, was admitted to the hospital March 23, 1928, with the complaint of pain in the left lower quadrant of three days' duration. Five days prior to her entrance to the hospital she was stricken with a dull ache in the left lower quadrant of the abdomen and shortly thereafter noted the presence of a mass about the size of an orange in that region. Two days after the onset, pain became more severe and on the night before admission was intense enough to cause her to feel nauseated. She has not vomited nor has she been constipated. Past history negative except for an appendectomy and hysterectomy performed in 1920. She was well-nourished and did not appear especially ill, but had definite tenderness in the left lower quadrant, with some increase in muscle spasm.

*Laparotomy Performed.*—At operation there was a gangrenous appendix epiploica of the upper sigmoid colon which was adherent to the abdominal wall and which created a little pocket into which several loops of small intestine were injected. These were easily dislodged and no damage to the circulation seen. The gangrenous appendix epiploica, which was a flat triangular structure about 1 by 1½ inches, was resected. Post-operative course was quite uneventful and she was allowed home on her fifteenth day after operation in good general condition.

Pathologic report (No. 37,420) described the microscopic section as being that of sub-acute inflammatory reaction in fat tissue.

She was seen later at the follow-up clinic and her condition described as being excellent and with no complaints.

Case placed in Group D—chronic perforated diverticulitis with abscess.

CASE XVI.—T. M., male, sixty-one years of age, was admitted to the hospital December 26, 1925, with the complaint of cramp-like pain about the umbilicus of twenty-four hours' duration. On the day preceding, he was suddenly stricken with a sudden sharp pain about the umbilicus and felt nauseated, but did not vomit. He has always been constipated, but has never had an attack of pain like the present one. Past history is quite negative. He looked acutely ill and had definite pain and tenderness across the lower abdomen.

*Laparotomy Performed.*—At operation the sigmoid was the site of a tumor which was inflamed and bound down. The mass was delivered with difficulty and about eight inches of the sigmoid with the mass was excised. An end-to-end anastomosis was performed. Appendectomy.

His post-operative course was complicated by the development of a fecal fistula on the fifth post-operative day. He was allowed home on the fifty-third day after operation with only a small granulating area present. He reported to the follow-up clinic May 8, 1926, where the notation was made that he had gained in weight, that his general condition seemed satisfactory and that there was only a slight serous ooze from his wound. He reported again December 9, 1927, when his condition was reported as being excellent and that he had returned to his work.

Pathologic report (Path. No. 33,585) described the microscopic section as showing acute suppurative inflammation in mesenteric fat tissue.

Case placed in Group D—Chronic perforated diverticulitis with abscess.

CASE XVII.—M. M., male, forty-six years of age, was admitted to the hospital April 13, 1927, with a three-day history of pain in the left lower quadrant of the abdomen. His past history was negative except for some flatulence and occasional indigestion. Three days prior to his entrance to the hospital, he was stricken with a sharp pain in the left lower abdominal quadrant and with its onset found that he was unable to void. This was the first time he had ever had any pain of this type. He was catheterized with subsequent relief. On the day preceding his admission the pain returned and at this time was dull and aching in character and aggravated by exercise. There is no radiation of the pain and at the time of admission there were no genito-urinary symptoms. He has been more or less constipated for many years. He was a well-developed and well-nourished man who looked acutely ill and who had definite pain and tenderness in the lower left quadrant of his abdomen. A tender mass could also be felt in that region.

*Laparotomy Performed.*—At operation there was an inflammatory mass which occupied the junction of the descending colon and sigmoid. When the inflamed appendices epiploicæ were liberated, a certain amount of pus escaped. One of the appendices epiploicæ was very markedly swollen and there was a perforation which ran from the tip of it into a diverticulum. A Miculicz' drain was inserted to the internal side of the inflammatory mass, and a rubber dam drain placed to the outer side, thus isolating it from the peritoneal cavity and leaving the aperture of the perforation close to the open wound.

His post-operative course was satisfactory and he was allowed home on the twenty-eighth day after operation with a small intestinal sinus still draining a small amount. (Discharged May 12, 1927.) He was seen at the follow-up clinic October 18, 1927, when he had only a slight amount of discharge at irregular intervals from the sinus. The sinus, itself, caused him no trouble. He reported again March 3, 1928, and again on November 13, 1928, when the note was made that there was no induration about his wound; that he was back at work.

Pathologic report (Path. No. 35,737) stated that the microscopic section showed inflammatory reaction in fat tissue with considerable fibrin and fibroblastic proliferation in the degenerated fat.

This case was placed in Group D—chronic perforative diverticulitis with abscess.

CASE XVIII.—A. P., male, sixty-one years of age, was admitted to the hospital April 16, 1927, with the complaint of generalized abdominal pain of three days' duration. Three days prior to entrance he was suddenly seized with generalized abdominal cramps which were not associated with either nausea or vomiting. No preceding history relative to the gastro-intestinal tract. He looked acutely ill with drawn facies and a retracted and rigid abdomen, and complained of generalized pain and tenderness over the entire abdomen.

*Laparotomy Performed.*—At operation there was thin pus all over the entire abdomen. The gall-bladder was enormously distended. Cholecystostomy performed. Exploration revealed the presence of an inflammatory mass at the pelvic brim in the region of the recto-sigmoid. A cæcostomy was performed and a drain inserted to the inflammatory mass.

His post-operative course was one of rapid decline and he expired on the fifth day after operation.

Post-mortem examination (Autopsy No. 6,349) revealed multiple diverticula of the sigmoid colon with perforation of a diverticulum and an acute generalized fibropurulent peritonitis. Anaërobic and aërobic blood cultures from the heart show *B. welchii*.

This case was placed in Group C—acute perforative diverticulitis with peritonitis.

CASE XIX.—P. W., male, thirty-seven years of age, was admitted to the hospital

August 14, 1925, with the complaint of pain in the mid-hypogastrium of two days' duration. The pain at the onset was sharp and stabbing in character but remained localized and did not radiate. Shortly after the onset, he vomited twice. His bowels have been quite regular. He has had four similar attacks in the past two years. He appeared acutely ill and had definite tenderness and rigidity in the mid-line below the umbilicus.

*Laparotomy Performed.*—On opening the abdomen some thin purulent fluid was found. A diverticulum of the sigmoid flexure was found markedly inflamed and with some fibrin on its peritoneal surface. The diverticulum was excised and a purse-string suture placed across the base. There was an area on the lower border of a loop of ileum near the mesentery which presented some fibrin, due most probably to contact with the perforated diverticulum. Cigarette drain placed to the site.

His post-operative course was uneventful except for a slight abcess of the wound which was evacuated on the fifth day after operation. He was allowed home on the sixteenth post-operative day (August 31, 1925) with his wound granulating nicely.

He was re-admitted to the hospital in November, 1929, with the story that, following his discharge in 1925, he had remained perfectly well for two years. At this time, 1927, he began to have vague epigastric distress associated with some pain. He has been constipated and has hæmorrhoids which bleed. His physical examination was normal except for some slight pain in the mid-epigastrium.

An exploratory laparotomy was performed and many dense adhesions between the cæcum and ileum and the ileum and sigmoid were found. These were freed throughout the length of the ileum.

His post-operative course was entirely satisfactory; he was allowed home November 27, 1929, his twelfth post-operative day, with his wound healed by primary union. He was seen again February 6, 1930, when his condition was reported as being satisfactory.

Group C—acute perforated diverticulitis.

CASE XX.—M. L., female, fifty-eight years of age, was admitted to the hospital May 23, 1928, with a draining colostomy wound in the left lower quadrant of her abdomen and with the history that for many years she had had attacks of "colitis" with frequent watery and sometimes blood-streaked stools. At the age of thirty she had had an exploratory laparotomy performed and that "nothing was found." Ten months ago (August, 1927) she had another attack and was admitted to St. Peter's Hospital in Brooklyn, N. Y. Communication from that institution states that at the time of her admission there she gave a history of generalized abdominal pain, attacks of vomiting and chills of eight days' duration. Laparotomy was performed and a diagnosis of diverticulitis of the sigmoid colon made. At operation, the diverticula were said to be encased in a fibrous mass, with the sigmoid pulled over and the omentum tied down to the mass. A colostomy was performed. She was discharged improved. Her wound has continued to drain and just prior to her admission to New York Hospital, amount has increased. She was a rather obese white female, not appearing acutely ill. Examination was quite negative except for draining sinus in left lower quadrant. At proctoscopic examination at a level of seven inches from the anal opening, the bowel appeared angulated, narrowed and the mucosa congested.

A barium enema did not fill the colon freely. The lower portion of the descending colon and the upper portion of the sigmoid were narrowed and spastic and diverticula were seen in this region.

*Laparotomy Performed.*—Operation was excision of fistulous tract with drainage of abscess and partial closure of the fistulous tract. There were two abscess cavities, one of which was in the pelvis and the other surrounding the sigmoid. The sinus of the fistulous tract ran down to the fat around the sigmoid colon.

Six weeks later following the drainage of the abscess cavities, the sinus tract was completely excised; a cyst of the ovary removed and the fecal fistula closed.

Her post-operative course was marked by grave abdominal distension on the first post-operative day, and, in spite of all therapeutic measures, was unrelieved. A jejunostomy was performed and a great deal of flatus and fecal material obtained. Concomitant with this she developed pulmonary and cardiac signs and expired on the sixth day after the closure of the colostomy. At post-mortem examination (Autopsy No. 6,600) diverticulitis of the sigmoid and the fecal fistula were noted.

This case was placed in Group D—chronic perforative diverticulitis with abscess.

CASE XXI.—M. C., female, fifty-three years of age, was admitted to the hospital August 14, 1916, with complaint of cramp-like pains over the entire lower abdomen of two days' duration. Onset of her present illness dates back to four weeks ago when she had similar pains accompanied by vomiting. There is also a history of some watery stools accompanying the initial attack. Past history is entirely negative. She was well nourished, appeared ill, with pain and tenderness across the lower abdomen, especially in the left lower quadrant. Radiograph disclosed diverticulitis of the sigmoid with probable adhesions around the sigmoid colon.

*Laparotomy Performed.*—At operation the sigmoid colon was lightly adherent to the left side of the pelvis and with a shortened mesosigmoid. It presented numerous rounded, shot-like thickenings in its wall. There was also a mass in the ampulla of the rectum about the size of a plum which was firm in consistence and adherent to the retro-rectal tissues. Examination of the descending colon revealed other nodules (about one hundred in all) varying in size from that of buckshot to that of a small cherry. One of these was excised for a biopsy. Inasmuch as there was no obstruction, no further operative procedures were performed. The post-operative course was entirely satisfactory and the patient was discharged September 19, 1916, with the wound healed by primary union and in good general condition. Before her discharge, a vaginal examination revealed that the nodule felt at the time of operation in the region of the rectal ampulla had melted away. It was evidently due to peridiverticulitis.

Pathologic report (Path. No. 20,428) describes the tissue removed at operation as saccule from the sigmoid colon which microscopically shows evidence of being derived from the large intestine and does not show any noteworthy abnormalities. She was seen at the follow-up clinic December 31, 1916, and was reported to have no pain; bowels move daily with only an occasional catharsis. Has worked since three weeks after discharge. Has gained in weight and strength and feels better than before her operation. Appetite and digestion are good. Classified as a good result. She was seen again in March, 1917, and states that she has been well.

This case was placed in Group D—chronic perforative diverticulitis with peridiverticulitis.

CASE XXII.—E. W., female, forty-eight years of age, was admitted to the hospital July 30, 1930, with a five-day history of generalized abdominal pain accompanied by nausea, vomiting and increasing abdominal distension. Her bowels had moved regularly up until forty-eight hours preceding admission but since that time she has passed neither gas nor formed stool.

She appeared acutely ill with respirations of 130 and a low leucocyte count. The abdomen is markedly and uniformly distended with no visible peristalsis. The abdominal wall is only slightly rigid and there is no tenderness at any point. There is no sign of fluid and the percussion note was tympanitic all over. Impression was that of an acute intestinal obstruction low down in the bowel.

*Laparotomy Performed under Local Anæsthesia.*—On opening the abdomen through an upper left rectus incision there was a gush of cloudy, yellow-green, foul-smelling pus with a marked *B. coli* odor. The intestines were uniformly dilated, injected and covered with plaques of fibrin. A loop of small gut was drawn into the wound and a Witzel enterostomy performed. Appendectomy done *via* a McBurney incision to exclude the possibility of an acute appendicitis. Two cigarette drains to the pelvis; one to the wound and two others left in the left rectus incision.

Post-operative course was one of rapid decline and she expired twenty-five hours later. Post-mortem examination (Autopsy No. 6,982) disclosed an acute perforative sigmoid diverticulitis with generalized peritonitis.

This case was placed in Group C—acute perforative diverticulitis with peritonitis.

CASE XXIII.—C. T., female, forty-two years of age, was admitted to the hospital January 29, 1930. This was her third admission to the hospital, her two previous admissions having been in May, 1914, when she was operated upon for chronic appendicitis. Following her operation her convalescence was quite uneventful. She now complains of pain in the left lower quadrant, of twelve months' duration. Pain is more or less constant and at times is quite sharp. For the month immediately preceding her admission, it had increased in frequency and intensity.

Radiographs of the colon report that the enema fills a rather redundant sigmoid and descending colon and the remainder of the colon normally and completely. High in the descending and in the left transverse colon are some bud-like shadows indicating diverticula. After evacuation the bowel is well emptied and the diverticula are more clearly seen. She left the hospital February 5, 1930.

This case was placed in Group B—chronic diverticulitis without perforation or complication.

CASE XXIV.—P. M., male, fifty-four years of age, was admitted to the hospital March 30, 1930, with the complaint of pain across the lower abdomen of fourteen hours' duration; pain most intense in the left lower quadrant of the abdomen. He had had two similar attacks, one one year ago and the other about five months ago. He states that following the ingestion of a heavy meal which he ate hurriedly, he began to have cramps in the lower abdomen. He tried to move his bowels with but little success. On the morning of admission, the pain returned, and following the taking of a saline purge and a colonic irrigation, he vomited once. The pain increased in severity and he decided to come to the hospital for relief. He has lost no weight; has passed no blood in his stools and has had no genito-urinary symptoms. There is slight distension of the abdomen and a slight amount of tenderness in the left lower quadrant. There is no rigidity and no mass is palpable.

After a barium enema it was reported that the upper sigmoid and the lower descending colon were definitely saw-toothed in appearance, indicating an early diverticulitis. Some of the diverticula in the sigmoid retain their barium. The day after admission his temperature dropped and the pain disappeared. He was seen July 14, 1930, at the follow-up clinic and reported as feeling well. He was seen again on October 26, 1930, at which time he was stated to have five attacks of pain similar to the one described above. The taking of some magnesium sulphate seemed to relieve the attack but a definite soreness persisted across the lower abdomen after the immediate attack had passed away. Nausea sometimes accompanies these attacks but he has only vomited once. He has continued working.

This case was placed in Group A—acute diverticulitis without perforation or complication.

CASE XXV.—W. J., male, fifty-two years of age, was admitted to the hospital June 12, 1930, with a two-months history of pain in the region of the umbilicus and in the left lower quadrant of the abdomen. The pain occurred in attacks and was accompanied by some elevation of temperature. Prior to this two-months period he never had any attacks. The abdomen was slightly distended and there were a moderate amount of tenderness and rigidity in the left lower quadrant.

After barium enema it was reported that the sigmoid and descending colon were very spastic and there were numerous bud-like shadows extending from the lumen of the bowel, indicating an extensive diverticulitis. (Fig. 7.)

Course in the hospital was quite satisfactory for the pain in the left side of the abdomen gradually subsided and the temperature returned to normal. He was discharged improved.

This case was placed in Group A—acute diverticulitis without perforation or complication.

CASE XXVI.—W. T., male, thirty years of age, was admitted to the hospital February 16, 1927, with a three-day history of pain across the lower abdomen. The attack started with a sharp sticking pain in the left lower quadrant and was accompanied by vomiting. Twenty-four hours later the pain radiated across the lower abdomen to the right side. He had been constipated since the onset of the attack. Physical examination was quite negative except for some pain and tenderness across the lower abdomen.

Laparotomy disclosed numerous diverticula in the descending and the sigmoid colon. Appendectomy performed. Exploration of the other viscera was negative.

Post-operative course was uneventful until the eighth day after operation when he was stricken with a sudden sharp pain in the right side of his chest and his temperature went to 102°. During the next two days he spat up some blood-streaked sputum. The temperature returned to normal on the thirteenth post-operative day. He was allowed home on the sixteenth day after operation.

This case was placed in Group A—acute diverticulitis without perforation or complication.

CASE XXVII.—V. N., female, thirty-five years of age, was admitted to the hospital on three occasions. Her first admission was January 22, 1925, at which time an appendectomy with drainage was performed for an acute appendicitis. Her second admission was in June, 1925, when a right salpingectomy was performed for tuberculous salpingitis. Her third admission was in January, 1928, at which time a hernioplasty was performed for the repair of a ventral (incisional) hernia. At the time of her second admission a barium enema was taken and the report stated that the sigmoid was considerably elongated and that there was some saw-toothed appearance in the upper portion of the sigmoid which suggested an early diverticulitis.

This case was placed in Group B—chronic diverticulitis without perforation or complication.

CASE XXVIII.—J. S., female, sixty-three years of age, was admitted to the hospital May 31, 1925, with typical history of biliary colic. Her past history was quite negative except for an appendectomy performed in 1901. A barium enema was given and the plates were reported as showing the lumen of the descending colon to be saw-toothed in appearance owing to the presence of diverticula.

This case was classified in Group B—chronic diverticulitis without complication or perforation.

CASE XXIX.—S. S., female, fifty-one years of age, was admitted to the hospital March 14, 1926, with a vague gastro-intestinal history of having had attacks of fullness and flatulence associated with a definite feeling of distress but without any real pain or cramps. Physical examination was essentially negative.

A gastro-intestinal barium series was completed and at the twenty-four-hour period the caput of the cæcum was still filled and the appendix irregularly outlined. There are in the sigmoid a number of rounded shadows irregularly filled with barium indicating diverticula.

This case was placed in Group B—chronic diverticulitis without perforation or complication.

CASE XXX.—W. B., male, fifty-two years of age, was admitted to the hospital March 19, 1916, with the history of increasing constipation of two and a half years' duration. Previously the bowel movements were regular but the stools small. With a diet and the use of mild cathartics he was afforded some temporary relief. For the past month he has had attacks of vague cramp-like pain across the lower abdomen and more especially in the left lower quadrant. He also states that his abdomen has increased in size. Physical examination is essentially negative except for some slight tenderness in the left lower abdominal quadrant.

*Laparotomy Performed.*—The upper part of the sigmoid for about four inches was markedly thickened and hard and the mesocolon infiltrated with hard nodules. The entire large bowel as far back as the cæcum was markedly thickened and distended. Resection of the sigmoid with subsequent anastomosis of the distal portion of the bowel to the cæcum. Drain inserted to the site. Convalescence entirely satisfactory.

Pathologic report (Path. No. 19,727) was diverticulitis of the sigmoid colon with stricture of the colon. Grossly, the specimen consists of a portion of the sigmoid colon about fifteen centimetres opened longitudinally. A little above the middle of its length is a constriction; and at this point the bowel measures four centimetres in inner circumference, the normal circumference being about ten centimetres. In the middle of the constricted part is a narrow opening that leads into a narrow diverticulum. Microscopic examination of the diverticulum wall shows it to be lined with granulation tissue that is infiltrated with numerous plasma round cells, eosinophiles and in some places



FIG. 8.　　　　　　　　　　　　　　　　　FIG. 9.

FIG. 8.—Radiograph of Case XXXII. Chronic diverticulitis without perforation or complication. Film No. 80,203 shows a large number of diverticula filled with barium in the course of the descending and sigmoid colon.

FIG. 9.—Radiograph from Case XXXV. Chronic diverticulitis without perforation or complication. Treatment was conservative. Barium enema reported (No. 96,957) that the colon filled completely but from the junction of recto-sigmoid upward to the lower descending colon there is a narrowing and irregularity of this region. The bowel is quite saw-toothed and suggests an early diverticulitis.

many polymorphonuclear leucocytes. The section of the sub-mucous tissues taken at the point of constriction shows similar inflammatory changes.

This case was placed in Group E—diverticulitis with stenosis.

CASE XXXI.—H. K., male, fifty-two years of age, was admitted to the hospital July 17, 1917, with a vague gastro-intestinal history. Full details were not obtained.

*Laparotomy Performed.*—At operation there was a mass the size of a walnut found in the wall of the descending colon. Two loops of small intestine were found to be adherent to the mass and were freed. The mass was excised and the defect repaired. Cigarette drain placed to the site.

Pathologic report (Path. No. 21,470) stated diverticulitis of the descending colon. Microscopic sections show a portion of the mucosa with evidences of a catarrhal inflammation; round-cell infiltration of the sub-mucosa, muscularis and the adjacent fat tissue.

This case was placed in Group D—chronic perforated diverticulitis with abscess.

CASE XXXII.—D. S., male, sixty-seven years of age, was admitted to the hospital December 17, 1925, with a rather indefinite history of flatulence and attacks of indigestion of seven months' duration. He stated that for the past seven months he had, on occasion, been constipated but did not relate his present feeling of weakness to that factor. He appeared a chronically ill man, with some enlargement of the liver and some loss of weight. Examination otherwise negative.

Routine barium enema showed that in the course of the descending and sigmoid colon there were a large number of diverticula filled with barium. (See Fig. 8.)

This case was placed in the Group B—chronic diverticulitis without perforation or complication.

CASE XXXIII.—M. L., female, fifty-three years of age, was admitted to the hospital in May, 1925, with the complaint of generalized abdominal cramps of two weeks' duration. Onset of her illness was rather vague in character and was accompanied with some flatulence and constipation. Physical examination was quite unsatisfactory owing to the obesity of the patient, though in the left lower quadrant of the abdomen there was some tenderness. Barium enema disclosed a diverticulitis of the sigmoid with a filling defect similar to that produced by a carcinoma.

*Laparotomy Performed.*—On opening the abdomen, the sigmoid and uterus presented as a single mass. Necrotic tissue was encountered to the left of the sigmoid in a cavity about two inches in diameter. No radical procedure was deemed advisable and a drain was placed at the site of the abscess cavity.

Her convalescence was entirely satisfactory and she was discharged from the hospital.

She returned to the hospital one year later and a follow-up barium enema was taken at that time (May 28, 1926). This was reported as diverticulitis of the sigmoid. There is no filling defect to be found in the sigmoid though there is still some spasm of the sigmoid present.

This case was placed in Group D—chronic perforative diverticulitis with abscess.

CASE XXXIV.—H. O., female, forty-two years of age, was admitted to the hospital June 1, 1925, with a history of attacks of lower abdominal pain associated with some flatulence of five years' duration. She states that she has never passed any blood in her stools nor has she ever been constipated. There is slight tenderness in the right lower quadrant of the abdomen.

Barium enema showed the sigmoid passed to the left and was situated just beneath the crest of the ilium. It was elongated and redundant and took a transverse course to the right iliac fossa where it joined the descending colon. In the course of the sigmoid and the descending colon were several diverticula visualized by the enema. The cæcum was large and not fixed.

Laparotomy with appendectomy. Post-operative course entirely satisfactory. She was discharged on her eleventh day after operation.

She was seen at the follow-up clinic October 4, 1925, and the note made that her condition was excellent; scar was healed, firm and painless. She had to take a cathartic every two or three days. Had no complaints.

This case was placed in Group B—chronic diverticulitis without perforation or complication.

CASE XXXV.—G. L., male, thirty-six years of age, was admitted to the hospital December 21, 1926, with the complaint of pain in the hypogastrium and in the region of the umbilicus of four weeks' duration. The pain was not localized but seemed to radiate to his hips and was accompanied by some tenesmus. He at no time passed any blood. Physical examination negative except for a mass said to have been felt above the prostate in the posterior rectal wall and seemingly attached to the sacrum.

Barium enema revealed the colon filled normally and completely but from the junction of the rectum and sigmoid upward to the lower descending colon, a definite

narrowing and irregularity of this portion. Area quite saw-toothed and is characteristic of an early diverticulitis. (Fig. 9.)

This case was placed in Group B—chronic diverticulitis without perforation or complication.

CASE XXXVI.—E. W., female, forty-three years of age, was admitted to the hospital May 25, 1927, for the first time, with the complaint of pain and the presence of a palpable tumor in the lower abdomen just above the pubis. She stated that for the two-weeks interval preceding her entrance to the hospital she had noted a fullness in the lower abdomen associated with some burning pain at the site of the fullness. She had not been constipated but had had the sensation of incomplete evacuation following her bowel movements. Attacks of flatulence on occasion. A mobile mass could be felt in the suprapubic region.

*Laparotomy Performed.*—Operation revealed, in addition to multiple fibroids of the uterus, a perforating tumor of the sigmoid. This mass occupied the lower portion of the sigmoid flexure and was adherent to the parietal peritoneum. There was also a partial constriction of the sigmoidal lumen. There were no perceptible surrounding lymph-node involvements. A supravaginal hysterectomy and a first-stage Miculicz' operation were performed. Five days later (May 31, 1927), the second stage of the Miculicz' operation was done.

Her post-operative course was stormy. A posterior colpotomy was required for the evacuation of a collection of purulent material in the cul-de-sac of Douglas. A transfusion of 500 cubic centimetres of whole blood was given. Anti-luetic treatment was also instituted. She was allowed home on the forty-third post-operative day and was to return at a later date for the closure of the intestinal fistula. (Third-stage Miculicz'.)

Re-admitted to the hospital three months later (August 2, 1927) at which time a closure of the draining fistula was performed. Subsequently the fistula re-opened and she was allowed home on the twenty-second day after operation. She was seen in the follow-up clinic October 15, 1927. Her condition was very satisfactory. The fistula had not closed but the discharge was constantly decreasing in amount and she was having normal bowel movements. She reported again in December, 1927, as being in excellent health. Had gained in weight. Sinus was not completely closed. Condition satisfactory.

Pathologic report (Path. No. 35,958) was Chronic perforation of the sigmoid colon. Grossly, the specimen consists of a short segment of colon, the wall of which is infiltrated with hæmorrhage. There is also some inflammatory reaction in the fat. Microscopic examination revealed ulceration and inflammatory reaction in wall of the gut and in the surrounding fat.

This case was placed in Group D—chronic perforative diverticulitis with abscess formation.

## REFERENCES

[1] Cruveilhier, J.: Traite' d'anatomie descriptive, vol. i, pp. 589-598, 1849.

[2] Virchow, R.: Arch. f. Pathol. Anat. u. Physiol., vol. v. pp. 334-348, 1853.

[3] Beer, E.: Some Pathological and Clinical Aspects of Acquired (False) Diverticula of the Intestines. Amer. Jour. Med. Sci., vol. cxxxviii, pp. 135-145, 1904.

[4] Monsarrat, J.: The Surgical Treatment of Diverticulitis. Brit. Med. Jour., vol. ii, pp. 41-46, July 14, 1928.

[5] Lockhardt, Mummery, J.: The Treatment of Acute Diverticulitis. Brit. Med. Jour., vol. i, pp. 588-590, March 30, 1929.

[6] David, V. C.: Sigmoido-vesical Fistulæ with Special Reference to Sigmoidal Diverticulitis. ANNALS OF SURGERY, vol. xc, pp. 1015–1026, December, 1929.

[7] Haggard, W. D.: Diverticulitis of the Sigmoid. Surg. Clin. N. America, vol. ii, pp. 1195–1201, Philadelphia, 1922.

[8] Rowden, W. H.: Diverticulitis with Particular Reference to Its Diagnosis by Radiology. Brit. Med. Jour., vol. i, pp. 381–383, March 1, 1930.

[9] Haines, W. D.: Diverticulitis of the Sigmoid. ANNALS OF SURGERY, vol. lxxxv, pp. 84–88, January, 1927.

[10] Newton, F. C.: Acquired Diverticula of the Colon: A Study of Forty-four Cases. Arch. of Surg., vol. xviii, pp. 1339–1358, April, 1929.

[11] Telling, W. H. M.: Acquired Diverticula of the Sigmoid Flexure. Lancet, vol. i, pp. 843–850, March 21, 1908.

[12] Telling, W. H. M.: Acquired Diverticula of the Sigmoid Flexure. Lancet, vol. i, pp. 928–931, March 28, 1908.

[13] Spriggs, E. I., and Marxer, O. A.: Multiple Diverticula of the Colon. Lancet, vol. i, pp. 1068–1074, May 21, 1927.

[14] Mayo, W. J.: Diverticulitis of the Sigmoid. Brit. Med. Jour., vol. ii, pp. 574–576, September 28, 1929.

[15] Lockhardt Mummery, J. P.: Diverticulitis and Its Surgical Treatment. Lancet, vol. i, pp. 437–440, February 27, 1926.

[16] Lockhardt Mummery, J. P.: The Etiology of Diverticulitis. Lancet, vol. i, pp. 231–232, February 1, 1930.

[17] Slesinger, E. G.: Diverticulitis. Lancet, vol. i, pp. 1325–1328, June 21, 1930.

[18] Rankin, F. W., and Brown, R.: Diverticulitis of the Colon. Surg., Gynec., and Obstet., vol. l, pp. 836–847, Chicago, May, 1930.

[19] Mayo, W. J.: Diverticulitis of the Large Intestine. J. A. M. A., vol. lxix, p. 781, Chicago, 1917.

[20] Telling, W. H. M., and Gruner, O. C.: Acquired Diverticulitis and Peridiverticulitis of the Large Intestine. Brit. Jour. Surg., vol. iv, p. 468, 1917.

[21] Chute, A. L.: Some Instances of Diverticulitis of the Sigmoid Opening into the Bladder. Boston Med. and Surg. Jour., vol. clxxxiv, pp. 118-121, May, 1921.

[22] Philips, C. E.: Diverticulitis of Sigmoid. Surg. Clin. of N. Amer., vol. viii, pp. 1495–1502, December, 1928.

[23] Weeks, A., and Brooks, L.: Ruptured Diverticulitis with General Peritonitis. Surg. Clin. of N. Amer., vol. vi, pp. 375–376, April, 1926.

[24] Rankin, F. W., and Judd, E. S.: Emphysema of the Scrotum the Result of Diverticulitis of the Sigmoid with Perforation. Surg., Gynec., and Obstet., vol. xxxv, pp. 310–312, Chicago, 1922.

[25] Habershon, S. O.: Pathological and Practical Observations on Diseases of the Alimentary Canal, Œsophagus, Stomach, Cæcum and Intestines, pp. 360–377, John Churchill, London, 1857.

[26] Klebs, Edwin: Handbuch der pathol. anatom., pp. 271–274, Berlin, 1869.

[27] Mayo, W. J., Wilson, L. B., and Giffin, H. Z.: Acquired Diverticulitis of the Large Intestine. Surg., Gynec., and Obstet., vol. v, pp. 8–15, Chicago, 1907.

# BACTERIOPHAGE IN SURGERY OF THE COLON AND RECTUM

## By Emmet Rixford, M.D.

of San Francisco, Cal.

Acknowledging a certain susceptibility to the contagious enthusiasm of d'Herelle for the clinical application of bacteriophagy, and having been inoculated in listening to d'Herelle's Lane Medical Lectures in 1928, we have looked to the bacteriophage with some degree of hope as a possible resort in some of the terrible problems of infection that every now and then confront the surgeon.

We are fortunate in having in Stanford University a so-called Bacteriophage Research Laboratory, of which Professor E. W. Schultz is director. Part of the research work of the laboratory is in the application of bacteriophagy in the field of clinical medicine, and the laboratory offers its services in determining the susceptibility to lysis of bacterial cultures sent by physicians.

The various kinds of bacteria in the culture are plated and each kind of bacterium is inoculated with a drop of bouillon suspension of a number of phages known to cause lysis of bacteria of the same sort and note made of the particular ones which cause most active lysis of the culture and a suspension of this particular phage or group of phages is furnished the clinician. For this service a nominal charge is made to assist in the support of the laboratory.

One reads in the literature such enthusiastic reports of clinical response to treatment by bacteriophage in so wide a variety of infections that if one belongs to the more confiding portions of the medical profession he is tempted to look to bacteriophage almost as a panacea for all bacterial ills, and yet when one talks with his friends he hears such discouraging reports and learns that one after another has given it up after conscientious trial that he wonders just where the virtue and truth lie. Is it blind enthusiasm on the one hand or faulty technic on the other? Before essaying a final verdict and although the burden of proof is on the advocate of any new therapeutic measure, the critic can have no standing in court until he can show that his errors of technic have been eliminated.

We are told that in certain diseases, *e.g.*, cholera, bacteriophage therapy is almost specific. At least, d'Herelle would claim almost 100 per cent., others (witness reports from Egypt from British sources) would assign a very much smaller percentage. However, a strong case is made out for the value of bacteriophage therapy. Yet, in other affections, the very contrary obtains.

Under these circumstances, items of individual experience, no matter how modest, may become useful contributions.

One important field in surgery in which there is great need for some effective anti-bacterial agent is the surgery of the colon, because of the high mortality of operations on the large intestine, especially as compared to the risk of similar operations on the stomach and small intestine. In addition to circulatory and mechanical peculiarities, the difference is due largely to the fact that in the stomach and small intestine the bacteria in their contents are ordinarily in relatively attenuated culture, while in the large intestine the bacteria are not only more numerous and of greater variety of sorts, but also more active. Given this suggestive explanation the problem is how to lessen the virulence of the bacteria of the contents of the colon and rectum.

Earlier and more accurate diagnosis and more rational preparation before operation, getting rid of bloody and mucoid contents by judicious catharsis, as well as improved operative technic, have materially lessened the mortality in operations on the colon and rectum, but there is still much to be desired. The mortality is still too high and in patients who survive operation, convalescence is often outrageously long.

Seriously complicating is the fact that in the large bowel, in addition to the great variety of aërobic bacteria ordinarily inhabiting the large bowel, there are often anaërobes occasionally of exceedingly virulent sorts. While the Welch *Bacillus*, *e.g.*, may in pure culture or in certain combinations be comparatively innocent, in combination with resistent strains of colon *Bacilli* or active streptococci, it increase the risk enormously—as in the following case:

A powerful middle-aged man, a fireman, woke early one morning, as he said, with "his piles hurting him." In fourteen hours a streak of blank, gangrenous, gas-filled tissue extended from the anus to the left axilla with gangrene of scrotum and penis; death in forty-eight hours in spite of incision from one end to the other of the discolored area. The atrium of infection was a small ulcer in the anus.

Again, in the case of a young woman who in an automobile accident, after having both legs broken—fractures compound—landed in a sitting position on a boulder in a creek bed. The right ischium cut through the skin and was broken. The open wound was beside the anus and when patient arrived at hospital twenty-four hours later, the wound was found to be black and to contain gas of characteristic odor. The Welch *Bacillus* was recovered. The obviously gangrenous tissue was excised, the wound irrigated with peroxide of hydrogen and painted with mercurochrome, this followed by subcutaneous injection of Mulford's poly-anaërobic antitoxin given subcutaneously and 100 cubic centimetres in 500 of salt solution intravenously. The patient recovered.

Whether it is established or not that the people of India who bathe in the Ganges and drink of the waters live by virtue of the destruction and attenuation of the bacteria by the multifarious bacteriophages with which the sacred waters abound—whether bacteriophage deserves the credit for the survival of the human race through the centuries before the practice of what we call sanitation—or whether bacteriophage is the answer to an American lady on a boat on a Holland canal witnessing the emptying and washing of pots-de-chambre and milk pans and the family linen in the

41

waters of the canal who remarked that "the canals of Holland would seem altogether to disprove the germ theory of disease," there is much promise that a rational administration of bacteriophage may be useful—even effective—in controlling infection with the bacteria of the colon.

But the problem of bacteriophage therapy is not as simple as one might suppose. It is not enough to take any phage and administer it to the sick man by mouth or hypodermically or locally. To be effective the phage must fit, it must be "matched," *i.e.*, be shown to cause lysis in the particular culture and strain of bacteria in point. One great defect, therefore, in the practical application of bacteriophagy to clinical problems, is the time required to seek out by trial in the laboratory an active phage for the particular case, for in many such as they occur clinically delay is disastrous.

Then d'Herelle and others have demonstrated that not only do different phages exhibit different degrees of activity, but the individual phage may lose its potency, or on the other hand it may have its potency increased at will by replanting in suitable bacterial cultures.

Again, since most bacteriophages known have been isolated from the intestinal contents or from sewage, it may be taken for granted that any individual phage has been living in the intestinal contents in symbiosis with the bacteria—developing, then, a sort of mutual relation with potency so adjusted to the resistance of the particular strain of bacteria as to set up a sort of balance so that the bacteria are kept in check but not destroyed. Moreover, the bacteria by long association with bacteriophage of perhaps low virulence have acquired new resistance to the activity of the phage. There are individual cultures of common bacteria, even strains of otherwise susceptible cultures which are strongly resistant to bacteriophage.

All this is true to an almost unbelievable extent in relation to the colon *Bacillus*—if one can speak of "the" colon *Bacillus*—a matter which is of supreme importance when attempting to control colon *Bacillus* infections in surgical operations either in prophylaxis or after wound infection has occurred.

Much of the practical difficulty in therapeutic use of bacteriophage and particularly in colon infections is the fact that time is often of supreme importance: witness the perforated appendix, perforation, operative or otherwise in diverticulitis—where the delay of three or four days necessary to procure a matched phage may be fatal—a circumstance which not only seriously limits the clinical value of bacteriophage therapy, but would seem to relegate it to the field of chronic colon *Bacillus* infections. But here it would seem to be of distinct value, *e.g.*, in chronic, even ulcerative colitis.

In acute infections, then, if treatment by bacteriophage is to be attempted, we are obliged to resort to blind application of mixtures of phages which have shown themselves active in causing lysis in a variety of strains of the colon *Bacillus* in the hope that one of them may "fit."

While, therefore, there is the possibility that a suitable phage may be

found for a particular case, other proven methods of treatment must be used just as if bacteriophage had not been discovered.

If bacteriophage has been used together with other means of treatment and the infection is overcome, one is, of course, in doubt as to what beneficial effect, if any, is due to the activity of the phage. In other words most of the clinical phenomena which may be ascribed to the activity of bacteriophage are often brought about by other means, such as evacuation of abscesses, drainage, the use of mercurochrome solutions, *etc.* It requires, therefore, an immense volume of such clinical evidence properly to estimate the credit due the phage.

It is well known that strains of colon *Bacillus* vary greatly in their susceptibility to lysis by particular bacteriophages even from one extreme to the other, some being so resistant that no phage in such a large collection as is kept alive in the Stanford Bacteriophage Research Laboratory will cause any degree of lysis.

On the other hand, not only do different phages vary in their activity in causing lysis of the same strain of colon *Bacillus*, but even an individual phage may be most erratic in its behavior—*e.g.*, failing to cause lysis of a particular strain or strains of colon *Bacilli*, but effective in causing lysis in distantly related or even unrelated bacteria.

Carcinoma of the colon and rectum is not only the most frequent and most serious disease of the large intestine, but it embodies most, if not all, the bacteriologic phenomena which obtain to a lesser degree in practically all other diseases of this organ which are susceptible to surgical attack, so that, if the problems of the operation for cancer can be solved and the operation be made safe, the same technic will solve the problem of other less serious morbid processes.

The mortality of the operation of excision of carcinoma of rectum and sigmoid is high but if the patient survives the operation he has a good chance to escape recurrence and remain well, for the simple reason that adenocarcinoma of the intestine ordinarily metastasizes slowly.

Barring, then, the occurrence of metastasis before operation, excision cures in a larger percentage of cases than in carcinoma of other organs. Cure, therefore, of carcinoma of the colon and rectum by operation is largely a matter of technic. The great danger is infection, for there is no reliable means of resecting the colon without some degree of soiling.

In carcinoma of the colon and other ulcerative conditions, perhaps with bleeding and with obstruction, a great variety of organisms may find suitable living conditions and have their virulence so increased as to furnish a most serious danger. It is for this reason that in carcinoma, for example, modern technic requires complete emptying of the intestine before operation is undertaken, often impossible without preliminary colostomy or cæcostomy (preferable in many cases).

One of the worst complications is the presence of virulent streptococci against which there are few active bacteriophages.

When one receives from the laboratory a suspension of bacteriophage, what is it that is delivered? Actually it is a quantity of bouillon in which bacteria have been grown and bacteriophage added, which phage is supposed to have, and ordinarily has destroyed all the bacteria. To guard against possible failure of complete lysis of the bacteria in the culture, and to prevent the application to the wound or hypodermically of virulent organisms, the broth is passed through a Chamberlain filter which normally catches bacteria but passes the smaller bacteriophage. It is conceivable that there is here a danger from the occasional inefficiency of the Chamberlain filter. This danger is known to be small, but it may be real.

Phage suspensions, therefore, before use should be limpid clear and before delivery a portion of the batch should be centrifuged and examined, even cultured, for the presence of bacteria.

The vehicle, broth, originally contains a certain amount of proteid, and unless this proteid is entirely destroyed (it usually is), it may give rise to proteid shock or anaphylactic phenomena which, in a patient weakened by sepsis, may be serious. Therefore, only small amounts may be injected subcutaneously, 2 to 3 centimetres, and the intravenous use, justified only in desperate conditions, but there most dangerous for the reasons stated, would best be avoided until the problem has been more completely worked out.

In a case recently reported by a colleague, that of a child suffering from serious staphylococcal osteomyelitis, after repeated intravenous injections of phage suspension the child recovered and the osteomyelitis speedily cleared, but the injections were followed by shock and rise of temperature to 106° F. so one wonders as to the safety of the procedure.

Because of the variation in activity of bacteriophage in relation to the variety and strain of bacteria, results may be expected only from the more active strains of bacteriophage, and experience bears this out. Moreover, experience shows that bacteriophage, notwithstanding its extreme penetrating capacity, is more reliable when administered in considerable amounts locally than when given subcutaneously.

And again the effect is often only temporary. Perhaps not enough emphasis has been placed on the value of repetition of the administration at not too long intervals until recovery.

The following cases, too few to warrant conclusions, are nevertheless suggestive:

CASE I.—A. N., aged sixteen. *Acute perforating appendicitis, wound infection, pelvic abscess.* Six days after operation drainage of foul pus. Leucocytes 21,000 to 25,000, 90 per cent. polymorphonuclears. One cubic centimetre suspension of stock bacteriophage known to be active against colon *Bacilli* injected into the arm, four cubic centimetres, into the peritoneal cavity between adherent coils of intestine. Two days later pelvic abscess was opened in left groin evacuating 500 cubic centimetres of thin foul pus, mixed culture of *B. coli* and non-hæmolytic streptococci. Drainage profuse and continuing. Four cubic centimetres of matched bacteriophage (anti-colon bacillus phage) injected into wound. In forty-eight hours drainage markedly less, odor notably

less, the change too marked and too rapid not to warrant at least some credit being given to the phage.

CASE II.—W. M., a man aged fifty-three, *perforative appendicitis*. Leucocytes 21,200, 87 per cent. polymorphonuclears, with localized abscess. January 14, 1930, drainage, evacuating 6 ounces of very muddy pus. January 24, rise of temperature to 103°, pulse 110, leucocytes 30,000, 82 per cent. polymorphonuclears. Large pelvic abscess opened suprapubically. Drainage continued. Culture showed Gram-positive cocci, pure growth of staphylococcus albus. February 15 matched bacteriophage injected 1 cubic centimetre in arm, 2 cubic centimetres into wound, followed by slight rise of temperature. Thereafter highest temperature was 37.2° C. Drainage rapidly ceased. It seemed that the bacteriophage had pretty definitely had a favorable influence on the wound. No further abscess developed.

CASE III.—H., aged sixty-two. A small *carcinoma of the rectum*, too small to have produced obstruction. Apparently a most favorable case for cure. February 13, 1930, operation, colostomy and local excision of the rectum by combined abdominal and perineal route. Exploration of the abdomen showed two tiny nodules on the posterior surface of the liver, inaccessible for removal for histologic purposes. Annoying infection of the abdominal wound occurred. Culture made. Culture showed mixed growth of *B. Coli* and staphylococcus aureus, the former predominating. In the bacteriophage research laboratory *B. coli* in several varieties determined by their sugar reactions were isolated and a variety of other bacteria, Gram-positive cocci and Gram-negative bacilli. February 20, seven days after operation, 1 cubic centimetre in deltoid, 4 cubic centimetres in rectal wound, of polyvalent anti-*B. coli* phage. Two hours later several chill with sharp rise of temperature for a few hours. Temperature thereafter normal. Convalescence normal—at least there was no further inflammatory trouble. March 7, matched anti-*B. coli* bacteriophage 5 cubic centimetres instilled into wound. March 8, ditto. Notwithstanding perforation at the suture line in the hollow of the sacrum, the wound healed without serious inflammation. March 25, 1931, operation for closure of the colostomy permitted a second abdominal exploration. The liver being found to contain many metastases, the colostomy was not closed.

CASE IV.—P. D., age sixty-three. *Carcinoma of the sigmoid colon with complete obstruction*, no bowel movement for nine days. Preliminary colostomy. February 14, 1930, tumor removed, end-to-end anastomosis, normal wound healing. March 4 operation for closure of the colostomy. Gut freed, closed with two rows of linen sutures with additional safety sutures of chromicized catgut. Region of suture line in intestine painted with mercurochrome. Three days later wound broke down, had to be opened. Five cubic centimetres matched anti-colon phage suspension instilled into wound, slight chill, temperature to 102° F. for a few hours. March 8 ditto, not followed by reaction. It was difficult to assign any very definite effect to the bacteriophage. Convalescence protracted but now, a year after operation, patient is enjoying robust health.

CASE V.—P. M., a fat man of fifty. *Acute diverticulitis*, not ruptured. June 28, 1929, an immense ventral hernia on the right side of abdomen repaired. Through a large McBurney incision on left side a tumor mass in the mesentery of the sigmoid was exposed near the brim of the pelvis. It was impossible to draw the mass up into the wound. Since there was no perforation, no peritonitis, nothing suggestive of carcinoma, no tumors in liver, cigarette drains were introduced to the region of the mesenteric tumor and led out of the incision. July 1 abscess broke spontaneously and discharged through the abdominal wound. Culture showed many bacteria of various types including Gram-negative bacilli of the *B. coli* group as well as long chains of streptococci, large Gram-positive bacilli and Gram-positive cocci in pairs. The colon bacilli seemed to be most numerous. July 8, patient was deeply septic; leucocytes 15,000 to 21,000, 82 per cent. polymorphonuclears; irrational at times; frequent liquid stools; discharge continued foul.

July 12 matched bacteriophage (anti-*B. coli*) 1 cubic centimetre injected hypo-

dermically in arm, 4 cubic centimetres instilled into wound. A few hours later the temperature which had averaged between 99½° and 100½° for a week, rose to 102° on two successive evenings, and thereafter slowly subsided.

July 17 bacteriophage 5 cubic centimetres instilled into wound. This was followed by a similar rise of temperature for three nights, after which the fever subsided and remained normal. The phage used was stock-pooled coli phages Nos. 1 and 2 of the Stanford Laboratory which on first two passages gave but incomplete lysis. On the third passage the lysis was complete. It was this filtrate that was injected. The discharge rapidly ceased, patient was out of bed five days later. August 5 left hospital. The recovery was so prompt after the injection of the phage that it seemed more than evident that the phage deserved much credit.

CASE VI.—V. T., age seventy-one. *An immense abscess filling pelvis and lower abdomen.* X-ray examination impossible because barium could not be induced to pass beyond the rectum. Temperature normal, leucocytes 9,000, November 13, 1930. Operation evacuating more than a litre of four mucopurulent material, probably due to slow perforation of a diverticulum although carcinoma could not be excluded. Culture gave only a few Gram-negative bacilli. Culture showed *B. Coli.* Lysis was complete with polyvalent anti-coli bacteriophage mixture No. 18 of the Stanford Laboratory. November 18 and 19 2 cubic centimetres of this phage suspension were injected hypodermically, several cubic centimetres instilled into the wound. Slight rise of temperature 100½ for two days. There was a very marked and almost immediate change in the character of the discharge. In particular the foul odor almost completely was destroyed. Four days later, however, there was again a rise of temperature and pulse rate. Otherwise than the change in the discharge there was no assignable effect of the phage. Liver or subphrenic abscess developed, patient became deeply septic in spite of further opening and drainage. Patient gradually went down and died February 18, 1931. The phage was used once or twice subsequently towards the end of the illness. In this case it would seem that the phage was not given a fair trial. It should have been used many times instead of twice early in the illness.

CASE VII.—G. T., aged fifty-seven. Immensely fat. *An acute diverticulitic abscess in the mesentery.* December 27, 1928, operation by another surgeon showed abscess size of a hen's egg in the mesentery of the sigmoid. Next day the abscess was opened and the intestine opened also, as in colostomy. Three months later an attempt made to close the colostomy. The wound broke down.

March 23 stock phage, not matched, instilled into wound. No noticeable effect. March 28 pus containing a variety of bacteria *B. coli* were isolated. *B. coli* phages were tested but gave only partial lysis. Complete lysis was given by a phage recently isolated from sewage. Matched phage 2 cubic centimetres intradeltoid. Some instilled into the wound. No noticeable effect. The colostomy remained open and two and a half years later a second attempt was made to close it. It might have been well to have made culture from the patient's intestinal contents isolating the principal bacteria and to have tried to have found phages which would be active against them. However, having on hand a quantity of anti-*B. coli* phage from the previous case (Mrs. V. T.) several cubic centimetres of this were poured into the would before closure. A fulminating infection followed. A gangrenous streak the width of one's hand rapidly formed and led from the wound around the flank as far as the mid-line. Culture showed a variety of organisms, *B. coli* and non-hæmolitic streptococci predominating. The latter failed to grow on sub-cultures, no Gram-negative bacilli were found suggesting anaërobes, nor was there growth in anaërobic culture. Cultures of the *B. coli* were subjected to the polyvalent anti-coli mixtures. There was no lysis of any culture, the bacteria being completely resistant to the phage. There seemed no use, therefore, in administering the phage at this time. In spite of wide incision, the gangrenous process extended and patient succumbed sixteen days after the operation.

This case brought up the interesting question as to whether the colon bacilli had

become resistant to bacteriophage because of the inoculation of the phage two years before. This seems unlikely, but one does not know.

These cases, being but seven, are useful merely as illustration of the difficulties of administration of bacteriophage therapy in *B. coli* infections rather than of any very positive or beneficial effect. In several of them it seemed only fair to give the phage some of the credit for the clinical improvement which followed quickly upon its administration, such as changes in the character of the discharge, lessening of odor, *etc.* In the other cases the phage completely failed as far as our observations could go. In nearly all of the cases the administration of the phage was followed by a temporary rise of temperature repeated next evening. The cases which showed most marked improvement were of sufficiently long duration to be classed as chronic. One cannot say that in any of the cases a life was saved by the phage, but it is very clear that it utterly failed in two, in one after some favorable promise, the other because of the infection with a phage-resistant bacterium, nothing could be expected from bacteriophage therapy. Still, it must be acknowledged that in none of these cases was bacteriophage therapy given a really fair clinical trial. None, *e.g.*, had the administration repeated often enough to get full or lasting effects.

The question of the use of bacteriophage in prophylaxis preliminary to resections of the colon needs investigation. It is conceivable that matched phages found to cause lysis of cultures of the intestinal bacteria in the case in which it is proposed to remove the colon, *e.g.*, in carcinoma, might be prepared before hand and used at the time of operation, being applied directly to the suture line of the intestine as well as by mouth before operation and intramuscularly. In several cases I have instilled bacteriophage suspensions into the free peritoneum in the region of an intestinal suture line and in none did peritonitis follow. Of course, in such use, or hypodermically or especially intravenously, only phage suspensions which have been tested for the presence of bacteria, and to the eye are absolutely clear, may be used.

# DIVERTICULITIS AND SIGMOIDITIS

## By Carl Eggers, M.D.

of New York, N. Y.

These two conditions are secondary to the presence of diverticuli in the wall of the sigmoid, so-called diverticulosis. A distinction is made because in some patients no gross diverticuli are visible, either by X-ray or on the operating table, and one finds only a thick-walled, red, œdematous sigmoid. Nevertheless the same etiologic factor is present in both.

Diverticulosis of the sigmoid and colon is usually looked upon as a rather innocuous condition to which little attention has to be paid. It is considered to be interesting rather than important. The etiology of the condition has aroused a great deal of curiosity and various explanations have been offered for their origin. That they are acquired false diverticuli seems well established. They increase in frequency as age advances, most of them being observed between fifty and seventy. It seems to be some change in the wall of the gut, perhaps due to stretching of a weakened muscular wall which allows these small bud-like projections to prolapse. As long as they empty regularly they produce no symptoms at all, or at most a slight feeling of fulness and discomfort with gas distension. Stagnation, however, may easily occur in these little pockets and it is this which makes them visible on Röntgen-ray films. (Fig. 1.) In case this stagnated material becomes putrefactive and causes irritation, a group of symptoms is initiated which require medical or surgical attention. It is this class of patients with which this paper is concerned.

Although diverticuli may be present along the entire course of the colon, usually only those in the sigmoid produce symptoms. This is probably due to the narrow lumen and the frequency of stagnation at this point. In what proportion of cases, with acquired diverticuli of the colon and sigmoid pathologic changes occur which produce symptoms, is difficult to say, largely because we have no accurate statistics as to the frequency of diverticulosis. In some hospitals it has been observed much more often than in others. Haines[1] states that during the year 1925 one case of acute diverticulitis with perforation was observed in the Cincinnati General Hospital, and that during the years 1915–1925 two cases with diverticulosis were found at autopsy. Since he states that the hospital admits 10,000 cases annually, of which number 20 per cent. are surgical, this records only three cases in 20,000 patients. Newton[2] on the other hand reports forty-four cases of proved instances of diverticulosis and diverticulitis in 56,000 cases admitted to the Peter Bent Brigham Hospital, Boston, over a period of fourteen years. This means one case in about 1,300 patients. William J. Mayo[3] states that records at his clinic show a total of 2,139 cases of diverticulosis. Among 31,838 X-ray

648

examinations of the colon for general diagnostic purposes, 1,819 cases showed diverticuli, or 5.71 per cent. Of the 2,139 recorded cases of diverticulosis, active diverticulitis was present in 696 at the time the patients were examined. Doctor Mayo is of the opinion that in about 12 per cent. of the cases with diverticulosis, acute diverticulitis will develop. As to throwing some light on the frequency of diverticulitis as compared with carcinoma of the sigmoid, it may be stated that during the same period in which 696 cases of diverticulitis were observed at the clinic, there were 2,354 cases with carcinoma of the sigmoid.



FIG. 1.—Large palpable tumor in case of diverticulitis which subsided spontaneously. Observed during two attacks at intervals of four years.

Depending on the degree of involvement of the affected portion of sigmoid, the symptoms may vary from irritation to the most severe degrees of inflammation or obstruction. The symptoms are not due to the mere presence of diverticuli, but to complications associated with them. Impaction alone will give rise to painful spasm, retention of gas, perhaps constipation or diarrhœa. Continued impaction will lead to ulceration and infection and may result in perisigmoiditis. Although the infection will usually empty through the lumen of the diverticulum into the gut, it may perforate exter-

nally and lead to abscess formation or peritonitis. It may dissect between the layers of the wall of the sigmoid until a large segment becomes involved forming a palpable tumor. Frequently, adhesions are formed to the abdominal wall, the bladder, or loops of small intestines, and these may lead to perforation into one or the other viscus with resulting internal fistulæ. At times the blood-vessels of the wall may become thrombosed, resulting in necrosis with perforation, or a pylephlebitis may extend to the liver. The cellulitis of the wall of the sigmoid itself may lead to obstructive symptoms, or adhesions of surrounding loops of gut may produce angulation and obstruction. There is no limit to the serious surgical complications which may result from acute sigmoiditis or diverticulitis.

It is possible to divide the cases clinically according to the pathologic changes and the course they are following into:

1. Simple diverticulitis and peridiverticulitis which subsides without operation.

2. Diverticulitis with complications resulting from perforation, such as abscess, gangrene, peritonitis and fistulæ.

3. Diverticulitis resulting in intestinal obstruction.

4. Diverticulitis associated with carcinoma.

The patients belonging to group one are in a way the more interesting from a diagnostic standpoint. The symptoms may be mild or they may be so severe as to be alarming. Some of these patients complain only of pain over the left lower abdomen, sometimes abdominal cramps, gas distension, a feeling of spasm, with associated constipation, perhaps alternating with diarrhœa. They are not acutely ill. On examination one may find some tenderness along the sigmoid, but nothing else. In other patients the pain may be sharp in character and shoot through the lower left abdomen, and one may find considerable tenderness over that region. Then there is a group of cases in which the symptoms are more distinctly of an inflammatory nature. The pain may be very severe; the patients sometimes state they feel as if they are going to die. A condition of shock may be present. There is definite tenderness and rigidity over the left lower abdomen and frequently in the suprapubic region. There is a rise of temperature, perhaps to 100° or 101°, and blood examination shows leucocytosis. Cramps, vomiting, and urinary symptoms may be present. Very often there is a palpable tumor which may extend upward as far as the umbilicus and may be mistaken for an ovarian cyst or tubo-ovarian disease. If the symptoms have persisted for some time, there may be loss of weight. Bleeding or discharge is uncommon. If present, it may suggest carcinoma. Experience has shown that carcinoma is not often associated with diverticulitis, but nevertheless it has to be borne in mind. A history of recurrent attacks rather than a steadily progressive one, as usually found in carcinoma, will help one in reaching a correct diagnosis.

In the more severe complicated cases the clinical picture may be very confusing. In the acute surgical emergencies, which not infrequently present themselves in the form of a perforation or obstruction, the diagnosis may be suspected but may not be made until the abdomen has been opened. In the less acute cases, on the other hand, the history, the symptoms and physical signs, and the X-ray may point the way to a correct diagnosis.

X-ray examinations are of the greatest value. One may use a test meal or a barium clysma. Sometimes one, sometimes the other, gives the better pictures. Frequently the best outline of diverticuli is obtained after evacuation of a barium clysma. (Fig. 2.) At times the changes in the sigmoid are



FIG. 2.                    FIG. 3.

FIG. 2.—Showing multiple diverticulæ in an acute case after evacuation of the barium. Perforated once and later had to be resected.
FIG. 3.—Patient admitted with diagnosis of carcinoma of sigmoid. History and presence of one diverticulum close to defect aided in the correct diagnosis of sigmoiditis. Was not operated on.

difficult to interpret. During the acute stage of the disease it is frequently not the presence of well-filled diverticuli which attracts attention, but rather a narrowing of the lumen with spasm and irregular filling defect. Carcinoma may be suspected and may be difficult to rule out. The presence of a diverticulum close to the lesion or of diverticuli in other portions of the colon may indicate the underlying lesion. (Fig. 3.)

*Report of Cases.*—This paper is based on twenty-four personally observed cases in all of which the symptoms were sufficiently severe to require surgical consultation. Some have been under observation for many years, while others are of more recent date. Several patients have had only one acute attack which subsided under medical treatment, while others have been seen several times with recurrent attacks. After a long period of observation

several of these patients finally had to be operated on, while still others were admitted as surgical emergencies and had to be operated on at once.

All patients were over forty years of age, only five being between forty and fifty, seven between fifty and sixty, nine between sixty and seventy, and three over seventy.

There were thirteen men and eleven women in this group.

It may be of interest to note that the majority belonged to the rather well-to-do class, twenty being private and only four ward patients. There was, however, nothing in their method of living which could be held responsible for the development of symptoms. Adiposity does not seem to be a factor.

*Symptoms and Physical Signs.*—In order of frequency the following symptoms and physical signs were noted:

| | | | |
|---|---|---|---|
| 1. Pain ....................24 patients | 8. Vomiting ................ 9 patients |
| 2. Fever ....................18 patients | 9. Obstruction .............. 8 patients |
| 3. Constipation ..............14 patients | 10. Perforation .............. 7 patients |
| 4. Palpable Tumor ..........11 patients | 11. Urinary Symptoms ....... 6 patients |
| 5. Cramps .................11 patients | 12. Loss of Weight .......... 6 patients |
| 6. Leucocytosis .............10 patients | 13. Diarrhœa ................ 6 patients |
| 7. Gas ....................10 patients | 14. Bleeding ................ 6 patients |

1. Pain was complained of by all, and was usually the outstanding symptom for which surgical aid was sought. It varied a great deal from steady pain situated in the left lower quadrant to cramp-like pain associated with incomplete or complete obstruction. It naturally varied with the existing pathological changes. In ordinary uncomplicated sigmoiditis or diverticulitis with thickening of the wall of the gut, and perhaps a palpable tumor, the pain may not be bad, but it may be extremely severe, cramp-like in character and associated with symptoms of shock. Patients sometimes feel as if they are going to die. The clinical picture is an interesting and alarming one, and after having been seen several times will aid one in the diagnosis in favor of sigmoiditis rather than tumor. The pain is apparently due to an intense spasm of a segment of gut. If perisigmoiditis develops or a perforation takes place with resulting abscess or peritonitis, pain and soreness due to the involved peritoneum may become more evident.

2. Temperatures over 99° were considered fever. Six patients had between 99° and 100°, while twelve had over 100°. In the uncomplicated cases the fever usually varied between 100° and 101°, while in those with complications it reached 103°–104°, or even 105°. The higher degrees were usually found in patients with perisigmoiditis, or peritonitis and abscess formation, but it is interesting to note that in two patients with very high fever continuing for weeks no peritonitis was present. There was an extensive infiltration of the wall of the gut which in one of them had extended to the bladder wall, the mesentery and the abdominal wall. All cultures from the tumor bed, from the involved lymph-nodes and from inflamed appendices epiploica were negative, and no organisms were seen in the smear. One

probably has to assume the presence of a phlegmon in the wall of the gut which eventually perforates into the lumen. We were able to prove the presence of such intra-mural abscesses in two of our cases in which a resection was done. (Fig. 4.)

3. Constipation is a common complaint of older people and its significance in this condition is not always apparent. At times it seems as if constipation and the associated straining at stool may be one of the causes of diverticulosis. Certainly constipation and the attendant impaction of fæcal



Fig. 4.—Showing multiple diverticulæ of descending colon and sigmoid. Perforated and had local abscess in the wall of the gut.

material in diverticulæ may precipitate an attack. During an acute attack constipation may become a prominent symptom and may suggest obstruction. It was noted in fourteen of the twenty-four patients.

4. In several patients a thickened tender sigmoid could be felt, and in nine of the twenty-four cases there was a definite palpable tumor. In several patients this tumor was quite large and in two it extended upward as far as the umbilicus. A diagnosis of ovarian cyst or tubo-ovarian disease is made not infrequently. It is the associated intestinal symptoms and an X-ray examination after a barium clysma which clears up the diagnosis. Of great

653

interest is the rapidity with which a large, tender, mass may subside under rest treatment, external applications and careful rectal irrigations. (Fig. 1.) In case perforation takes place with abscess formation, drainage may be established.

5. Cramps may be very severe, and are often aggravated by taking a laxative. They are due to spasm of the affected portion of gut, or to intestinal contractions resulting from an obstructive lesion. Those due to spasm seem to be the most painful.



FIG. 5.—Gelatinous carcinoma in the presence of multiple diverticulæ. Complete obstruction had resulted. Resection was done.

6. Leucocytosis is frequently found, especially in patients with fever. It may be unusually high, with a high polymorphonuclear count. The higher counts have not been an indication of the presence of pus, but have been found in patients in whom prompt subsidence of symptoms occurred after a few days without abscess formation. The highest count reported was 48,800 with 90 per cent. polymorphonuclears, which was verified by having it repeated. This patient was operated on while she had a temperature of 103°. No pus was found but there was an extensive cellulitis of the wall

of the sigmoid, with involvement of the mesentery, urinary bladder and abdominal wall. All cultures were negative. She eventually recovered without any evidence of having had an abscess. One may assume the presence of an intra-mural abscess which evacuated into the lumen of the gut.

7. Associated with constipation there is frequently retention of gas with discomfort, distension and gurgling. Sometimes it is felt to stick on the left side. In seven of our patients this symptom became an important one. Inability to pass gas is of as much significance in this condition as it is in



FIG. 6.—Gelatinous carcinoma developing around a large diverticulum. Later perforated and formed a local abscess.

other forms of obstruction. In one of our patients with acute perforation into the free abdominal cavity, there was enormous distension with a sensation as if he were blowing up.

8. Vomiting occurred in all the patients with complete obstruction as well as in several of those inflammatory cases presenting a palpable tumor. The proper evaluation of this symptom is important, whether it indicate obstruction or be reflex in character, for on that depends in some measure whether an operation is to be performed or the patient treated conservatively.

9. Obstruction may occur and may be incomplete or complete. It may be due to the mass itself which, by thickening of the wall and hyperplasia associated with the inflammation, brings about an incomplete or complete obstruction, or it may be due to angulation of loops of small gut which have become adherent to the inflamed sigmoid.

In five of our cases, obstructive symptoms were partly due to adhesions angulating loops of small gut. They could be separated and that element of the obstruction relieved. In one of them a portion of small gut had to be resected. In another there were two separate obstructions, one resulting from the sigmoid mass, the other from angulated small intestines. The diagnosis of the two conditions could be made before operation. Four patients had incomplete obstruction due to the mass itself, and five had complete obstruction. In two of the latter the pathological examination revealed an associated carcinoma. (Figs. 5 and 6.)

10. Perforation took place in seven patients. In three there was local abscess formation. In two of these the abscess was plastered against the wall of the gut and could be lifted out with the tumor mass; while in the third case a large abscess developed which contained pus and gas and had to be opened externally.

In four patients an acute perforation took place into the free peritoneal cavity. One of them was drained early and recovered, another was treated expectantly for peritonitis without knowledge at that time of the underlying cause, and finally recovered, while the other two died.

11. Urinary symptoms were present in six patients. Whether in each case these symptoms had any definite relation to the sigmoiditis is not possible to state. In one female patient the bladder wall was definitely involved, but no perforation had occurred. In another female patient there were extensive peritoneal adhesions involving also the bladder. The other patients were men, in whom the prostate may have played some rôle. In one male patient, however, the symptoms were sufficiently severe to suggest calculus, and X-ray examination with catheterization of ureters was done to rule that out. In another old patient a diagnosis of carcinoma of the sigmoid with perforation into the bladder had been made, but examination showed the colon lesion to be a sigmoiditis, and the bladder affection a cystitis secondary to the sigmoiditis.

12. Loss of weight was a factor in only a few cases in whom long-continued inflammation with associated digestive disturbances or an associated carcinoma were responsible.

13. Diarrhœa was not a common symptom and was never severe. In some patients it alternated with periods of constipation.

14. Bleeding. In six patients gross blood had been noticed from time to time. Whether in all cases it had its source at the site of the sigmoid lesion could not be definitely determined.

In one patient a gangrenous inflammation of the sigmoid with vessel changes was present.

In another, a carcinoma was found, and in a third there was intense congestion of the mucosa. In these cases no doubt the bleeding came from the lesion, while in the others it may have come from hæmorrhoids.

Bleeding is not an important symptom and if present should make one think of a complication or an associated carcinoma.

In several patients a proctoscopy was done, but no diagnosis of sigmoiditis was made by means of it.

*Bacteriology.*—Some attempts have been made to gain information about the organisms responsible for the infection. There have been no uniform results. In two very sick patients with high fever and most extensive infiltra-
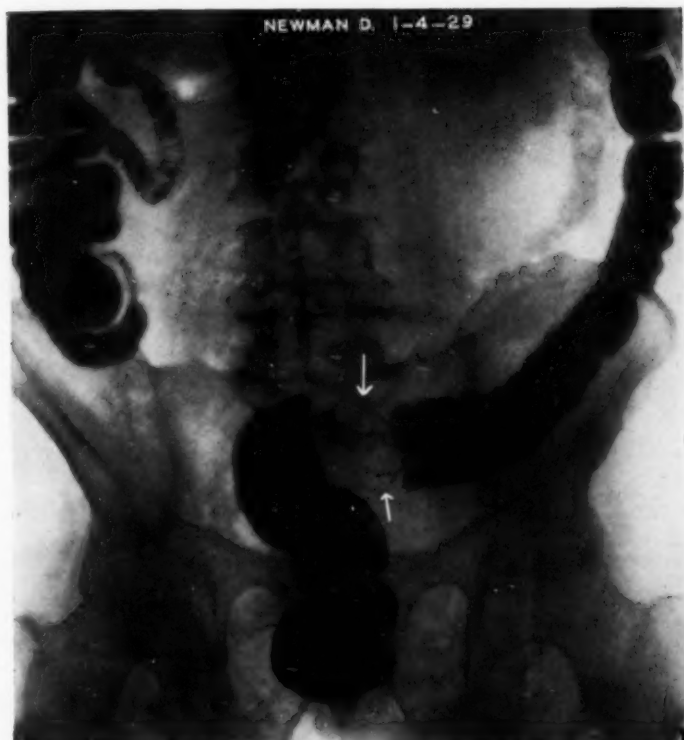


Fig. 7.—Irregular filling defect due to acute sigmoiditis. Had exploratory operation done. Perforated a year later and formed a large abscess.

tion of the wall of the gut (in whom cultures were made from the peritoneum, from small areas of localized abscess due to breaking down of tissue, or from involved lymph-nodes), all reports were negative. The explanation probably is a small suppurative focus in the wall of the gut with extensive cellulitis spreading from there.

In two patients with peritonitis, due to acute perforation, streptococci and colon bacilli were isolated. A large abscess containing pus and gas in another case yielded *Bacilli coli communior*.

Gram-positive bacilli and cocci were observed in the stained section from the wall of a very acute case showing gangrene and perforation.

In another patient, in whom a resection was done, *Bacilli enteritidis* was isolated from a small abscess in the wall. No anaërobic organisms were found. Gram-positive cocci were found in the stained-tissue sections.

*Course of the Disease.*—Of the twenty-four cases reported, eleven have so far not been operated on. Several of them had only one acute attack which subsided with appropriate medical treatment, while a few have been under observation several times.

At the time of discharge all of these patients were informed of the pathological condition underlying their complaint and they were made familiar with the measures calculated to avoid recurrence, such as the use of mineral



FIG. 8.—Cross section of colon (x 20). The larger lumen is that of the gut. Above it is an acute abscess (in a diverticulum), the walls of which are partially lined by intestinal mucosa. The remaining portions of the mucosa have been destroyed by the suppurative process.

oil to insure a daily evacuation, avoidance of food with a large residue, and avoidance of overeating. That these measures apparently have some success is evidenced by the fact that most patients have remained free from recurrence. On the other hand, the recurrences have shown that there is no positive safeguard in avoiding acute sigmoiditis or diverticulitis in those patients afflicted with diverticulosis. The condition must be considered a serious one, and one must be prepared at any time to see a recurrence or a complication requiring surgical intervention.

In thirteen of the twenty-four patients some kind of surgical interference was indicated or became imperative. Some of these patients had been under observation for a long time and were known to have diverticulosis, while others were seen for the first time during the acute surgical emergency.

*Treatment.*—Patients with temperatures under 100° and those with no fever at all were treated ambulatorily. They were put on a light diet with little residue, and mineral oil was ordered for morning and evening. Rectal irrigations were given when indicated and perhaps local applications of heat.

All the more acute cases were put to bed. They were carefully observed for evidence of perforation. Aside from fluid diet, and perhaps a little mineral oil *per os*, nothing was ordered until a definite diagnosis could be made. A blood count was done. As soon as it was considered safe, an X-ray was taken, occasionally after a bismuth meal, but usually after a barium clysma, given carefully to avoid excessive pressure. With rest, perhaps application of an icebag or heat, and with careful rectal irrigations the acute symptoms would usually subside in a few days and the patient become ambulatory. It is interesting to observe how quickly a large mass may disappear. In case there was unusual delay the reason for that was looked for. In a few cases X-ray treatment was apparently of value in aiding the dissolution of the mass. If local complications developed, an operation was indicated.

When surgical treatment was undertaken it was always for a definite indication, either for recurrent attacks, for abscess formation, for acute perforation, for incomplete or complete obstruction, or on the suspicion that one might be dealing with a carcinoma.

In six of the thirteen cases operated on, the operation was deliberately planned after sufficient observation leading to a correct diagnosis, while in the other seven cases operation was done for a surgical emergency, either acute perforation or obstruction.

The nature of the surgical procedure depended on the conditions found. Frequently several procedures had to be combined to meet the demands: Freeing of adhesions, two cases; drainage—perhaps with freeing of adhesions, six cases; colostomy, seven cases; cæcostomy, two cases; resection of small intestines, one case; resection of sigmoid, six cases.

The simplest operation was separation of adhesions with freeing of the sigmoid in two patients in both of whom there was a suspicion of carcinoma. In six patients drainage alone was instituted for abscess or for acute perforation, or the tumor mass was freed out of its bed and drainage then instituted. Colostomy was performed seven times. In only one patient did it become necessary to establish a permanent colostomy, while in the others it was a temporary measure. A cæcostomy was done twice; in both patients it remained permanently as a safety valve. One of these is living. He has normal evacuations but keeps the cæcostomy with a tube as a vent. An attempt at closure sometime ago led to recurrence of the sigmoid symptoms. The patient's age and general physical condition make a radical operation inadvisable.

In one case a portion of small intestine had to be resected on account of obstruction resulting from peritonitis secondary to sigmoiditis. The sigmoid inflammation subsided without resection. In six patients a resection of the sigmoid was done. In one of them a primary resection with end-to-end anastomosis was performed, while in the other five the Mikulicz technic was used. One of these patients has a permanent colostomy.

*Pathological Examination of Tissue.*—The gross specimens removed in cases of sigmoiditis show a red, hard, often rather nodular tumor. The appearance is due to thickening of the wall, involvement of the appendices epiploica and diverticulæ, as well as adhesions of surrounding tissue. Frequently, there is a fibrin deposit and there may be an encapsulated abscess. The serosa is usually rough and granular. On opening the specimen it is surprising how little actual obstruction exists. The mucosa may be normal, or it may show redness and superficial erosions, but no real ulceration. It is at once evident that the lesion does not arise in the mucous membrane as in the carcinoma, but is confined to the wall and perisigmoid tissues. Although sometimes a good-sized diverticulum is found, perhaps filled with pus, it is not always possible to demonstrate openings into diverticulæ or even into a single diverticulum. This corresponds to some of the X-ray find-
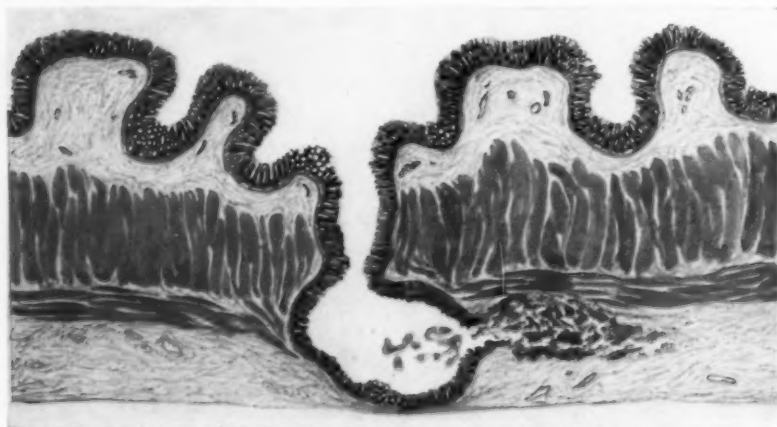


FIG. 9.—Semidiagrammatic presentation (x 200) (after Aschoff). The diverticulum has penetrated to the serosa. A perforation of the diverticulum has occurred.

ings in acute cases in which no definite diverticulæ are shown, but only a narrow lumen with an irregular filling defect. Pressure on such a specimen may cause oozing of retained fæces or purulent material from several small ducts in the wall, which are not visible on the serous surface of the gut as diverticulæ. They seem to be buried in the thick œdematous wall of the sigmoid. It has seemed to us that during the early stage, while a diverticulum is pushing through the wall of the gut, and before it becomes visible on the serous surface, it may become infected and perforate. But instead of perforating externally beyond the serous surface to form a peridiverticulitis or peritonitis, it may perforate laterally into the wall of the sigmoid where the infection spreads between the layers. This probably accounts for some of the extensive tumefactions of the sigmoid which can be felt through the abdominal wall. In two of our specimens we were able to demonstrate these intra-mural abscesses. (Figs. 8, 9, and 10.)

The microscopical examination of all resected specimens showed diverticu-

litis or sigmoiditis, while in two there was an associated carcinoma, both being gelatinous carcinoma. (Figs. 5 and 6.)

*Results.*—Of the eleven patients who recovered without operation six have remained well for several years, while five have had trouble at times and are probably no better off than they were before they came under observation. Unfortunately there is no specific treatment aside from general hygienic measures. The symptoms in these patients have at no time been sufficiently severe to warrant resection. There is some advantage in having a positive diagnosis, however, for these patients can take care of themselves and guard against recurrences to some degree. Should an acute surgical complication develop, prompt and correct treatment may be instituted.



FIG. 10.—Cross section of appendix (x 20). The serous and muscular coats have been torn in sectioning. The larger central lumen is that of the appendix, the smaller one that of a diverticulum. An acute suppurative reaction has occurred about the diverticulum.

Of the operated cases five have died; four soon after operation and the fifth about a year later. Two were almost moribund when admitted and the operation was simply a desperate attempt to save them. All were very sick, as the following short abstracts will show.

CASE I.—Mr. M. O., forty-six years, admitted four days after an acute onset of abdominal pain and vomiting. For years had attacks of indigestion, was troubled with gas, and at times had colicky pain in the left lower abdomen. Little blood in stool for many years. On admission chief complaint was pain and incessant vomiting. Looked very sick, eyes sunken, temperature 100°–102°, plus 90-120. A tender mass was palpable in the left lower abdomen with signs of peritonitis. White blood cells, 16,900; polymorphonuclears—86 per cent. Barium clysma, given carefully, showed deformity of sigmoid, 6 to 8 inches in length. Barium passed through slowly and filled upper descending colon and part of transverse. Operation was done within a few hours after admission. Suppurative peritonitis was found; pus removed by suction. A large inflamed

sigmoid was exposed, partly covered with fibrin. Loops of small gut were adherent on the mesial side Upon separating them there was a gush of foul-smelling pus from a large abscess. In contact with this the wall of the sigmoid, over an area the size of a silver dollar, was gangrenous and flaccid. Pus had extended upward between the loops of intestines along the posterior abdominal wall and in the left lumbar gutter. To prevent further leakage and later be able to resect the affected gut, a first-stage Mikulicz operation was done. The arteries of the mesentery were found normal but several veins were thrombosed. Ample drainage was established. In spite of this the condition did not improve. Temperature rose to 107° and the patient died on the fourth day.

*Pathological Diagnosis.*—Chronic sigmoiditis, acute suppurative perisigmoiditis. Sections stained for bacteria showed gram-positive bacilli and cocci.

Case II.—Mr. G. E., fifty-three years old, gave the following history: Abdominal distress lower left quadrant for three months, associated with soreness. No medical attention. Bowels normal. No urinary symptoms. Increased pain and fever for nine days. Became worse six days ago, had to go to bed and consulted his physician.

*Chief Symptoms.*—Pain and discomfort lower abdomen, vomiting, and chills and fever. One severe chill four days ago following rectal irrigation. Diverticulitis had been suspected and an attempt had been made to improve his condition sufficiently to transfer him to the hospital for X-ray examination. Blood count had been low. He had apparently improved, and on the morning of admission he felt quite well, had normal temperature and was sitting out of bed. Early that afternoon he had a sudden agonizing pain in the left lower abdomen, he became covered with perspiration and developed a chill lasting half an hour. Temperature rose to 104.5°. After this, pain continued severe and the abdomen became enormously distended. The patient was seen by us about five hours after this acute onset. With the history of left-sided pain a diagnosis of peritonitis secondary to diverticulitis was made. Immediate operation done. Thin pus with colon odor was present under pressure. Loops of small intestines were acutely inflamed, matted together with fibrinous exudate, and pus flowed from every direction. Chief focus of infection was in the left lower quadrant. The sigmoid was a hard, infiltrated tumor mass bathed in foul-smelling pus. No gross perforation found. Pus removed by suction. Extensive drainage instituted. The peritonitis did not clear up. Heart and kidney complications developed and the patient died on the eleventh day. The culture showed colon bacilli and short chain streptococci.

Case III.—Mrs. M. P., sixty-eight years old, had been under observation for a long time on account of nausea, vomiting, loss of weight, and constipation associated with pain in the lower bowel. An X-ray diagnosis of multiple diverticulæ of the sigmoid with obstruction had been made. When she came under our care she had been kept alive entirely on intravenous glucose injections and hypodermoclyses. She had apparently a very marked reverse peristalsis with fæcal vomiting. The first stage of a Mikulicz operation was done under Pernocton anæsthesia and a small opening immediately made in the gut to favor drainage. There was no improvement. The involved area was then resected, but vomiting continued. Transfusion and feeding into the colon did not improve the general condition. She died eight days after operation from general asthenia. The specimen presented numerous diverticulæ filled with hard concretions. At one place the lumen was completely obliterated by a semi-gelatinous translucent tissue which was later reported gelatinous carcinoma. (Fig. 5.)

Case IV.—Mr. N. D., seventy years old, was operated on by us in 1926 for a right subphrenic abscess and a liver abscess of amœbic origin. He had some intestinal symptoms at the time, but they were insignificant compared with his chief complaint. He recovered and gained much weight. After a while he began to have attacks of pain over the left lower quadrant, associated with constipation and discharge of blood and mucus. Proctoscopy and X-ray examination showed a filling defect with irregular configuration. (Fig. 7.)

Finally, in 1929, he was operated on by another surgeon. An inflammatory lesion of the sigmoid was found, and after separating several bands the abdomen was closed without drainage. A resection with anastomosis was considered to be the proper procedure at the time, but technical difficulties, the advanced age of the patient, and his poor general condition made that inadvisable. He continued to have attacks of pain in the left lower abdomen with constipation and blood and mucus in the stools. Six weeks before admission his condition became quite bad, he had spasms of pain, then again a steady soreness in the left lower quadrant. Heat had relieved him some. There had been no vomiting. When admitted he was very sick, he made a septic impression, his evening temperature rose to almost 104°, and the pulse was 110. Underlying the left rectus scar there was a firm, rounded, tender tumor mass extending upward as far as the umbilicus. Blood examination showed white blood cells, 28,400; polymorphonuclears, 84 per cent. Fluctuation developed in the mass, a small incision was made and much foul pus and gas evacuated. After a few days fæces also began to discharge through the wound. In spite of the drainage the patient died from sepsis and general exhaustion. Culture of pus showed *Bacilli coli communior*.

CASE V.—Mrs. A. S., fifty-eight years of age, was admitted for acute intestinal obstruction. It was known that she had diverticulosis of the sigmoid and colon, having been under treatment for that condition from time to time. It had been verified by X-ray a year before. During the last few weeks pain in the left lower quadrant had become more intense and was associated with spasm of the sphincter. A tender mass had gradually developed on the left side and rectal examination had shown a tender mass filling the cul de sac. Two days before, she began to have colicky pain over the entire abdomen, associated with distension, vomiting, and constipation. The condition rapidly became worse, necessitating admission to the hospital. She had a temperature of 100.6°, and her pulse was 110. The abdomen was enormously distended, and was conical in shape. It was tender all over but there was no rigidity. Loops of gut could be palpated, but no peristalsis was noted. Vaginal and rectal examinations were unsatisfactory; the pelvic organs seemed to be matted together. No detail could be made out. There was no tumor to be felt. Diagnosis of intestinal obstruction was made. The history indicated the sigmoid region as the site of the lesion most likely inflammatory in character. This did not quite explain the findings, however, especially the conical-shaped abdomen. Further observation advised. The patient was catheterized and a rectal irrigation given. No fæces returned, but considerable gas. On re-examination stiffening of the gut was noticed, indicating obstruction of the small gut.

A barium clysma was then given. It showed an extensive lesion of the sigmoid, but a small amount went throught into the descending colon almost to the splenic flexure, outlining several diverticulæ. Hugely distended coils of small intestines were also noted. This finding seemed to point to two lesions: 1. An acute obstruction of the small intestines. 2. An incomplete obstruction of the sigmoid.

An immediate operation was done, using a midline incision. Considerable free fluid found, clear, nonodorous. All cultures were negative. There were extensive adhesions. Colon and small intestines were enormously distended and red. The sigmoid for its entire length was contracted, hard, nodular, and its mesentery had been obliterated by the inflammatory process. A loop of small intestines was firmly adherent deep in the pelvis on the left side, and several other loops had formed light adhesions. The angulated loop was carefully and bluntly separated. It had apparently been completely shut off. There was an area of constriction about 1½ inches long. As soon as released, intestinal contents passed through into the collapsed gut below. The pelvic organs were small and matted together. There was no pus found. On account of the enormous distension of the colon a cæcostomy was done through a separate incision on the right side. Cæcum opened at once and about 1000 cubic centimetres thin fecal material removed by suction. Median incision closed without drainage.

The patient reacted well. The cæcostomy began to function and gas and fæces were also passed through the rectum. Temperature, however, continued, and after a while a tender mass developed in the left lower abdomen. Conservative treatment was continued, supplemented by X-ray and vaccine treatment until the impression was gained that a perisigmoid abscess had formed. An operation was done for this condition but no pus was found, just hard infiltrated inflammatory tissue. Later a perforation of the sigmoid developed spontaneously on the left side with fæcal discharge. It became apparent that it would never be possible to resect the involved sigmoid on account of the extensive involvement and the numerous adhesions. A permanent colostomy was therefore done as close to the lesion as possible, and the cæcostomy closed. After a while the patient became ambulatory but she remained an invalid and died about a year after the first operation.

The remaining eight patients who were operated on are living. On account of the interest attaching to them a short report of each is given.

CASE I.—Miss V. L., forty-eight years old, had for two years complained of severe attacks of cramps in the left lower quadrant, associated with tenesmus and at times diarrhœa. Examination showed tenderness over the sigmoid, but no mass. Rectal temperature varied from 99°-102°. Examination of the fæces was negative for blood. Repeated X-ray examinations showed constant irregularity and narrowing of the lumen of the sigmoid with retention of barium. A diagnosis of sigmoiditis was made, and on account of suspicion of carcinoma an operation was advised and performed by another surgeon. An inflammatory condition was found and the abdomen was closed without drainage.

CASE II.—Miss A. S., forty-eight years old, was first seen four weeks after the onset of an acute disease which was at first diagnosed as influenza, and after a few days as pelvic peritonitis of unknown origin. She had been confined to bed all this time and had run a temperature of 103°-104°. She had complained of vomiting and pain over the lower abdomen, associated with urinary difficulty and constipation. A daily rectal irrigation had brought some relief, but only a little fluid could be introduced at a time. She looked sick and very anæmic. The temperature was 103°, and the pulse 104. The general examination was negative. In the lower left abdomen a tender mass could be felt which apparently arose from the pelvis and extended upward to the level of the umbilicus. Vaginal examination showed the uterus and right adnexa normal, while on the left side a mass could be felt, situated high, and apparently plastered against the lateral pelvic wall. It was very tender. Rectal examination verified these findings. A diagnosis of sigmoiditis was made and an operation advised.

Through a median suprapubic incision an interesting picture presented itself. A large, red, nodular sigmoid tumor was adherent to the lateral pelvic wall. An infiltrative process extended from here into the anterior abdominal wall and the urinary bladder, to both of which the tumor was adherent. By careful blunt and sharp dissection the tumor was gradually separated from the bladder and then from the pelvic wall. There was no abscess present. After freeing it, the mass could be drawn upward for about 3 inches away from the bed where it had been adherent. The wall of the gut itself was thick and œdematous, and the appendices epipolica and the mesentery were extensively involved. A culture was made from the tumor bed and one of the inflamed appendices, as well as several enlarged lymph-nodes, were removed for culture and section. All these cultures and sections were subsequently reported negative. The bladder slipped back into position. The pelvic organs were found to be normal. The appendix was removed. A cigarette drain was inserted into the tumor bed and the normal sigmoid placed over it, while the inflamed sigmoid was left free at a higher level where it would most likely not form new adhesions. After a few days the temperature came down, but did not reach normal for several months. During all this time there was a moderate amount of drainage containing streptococci. At times the

fever would rise to between 103° and 104° for a few days and then subside again. Several transfusions were given and two courses of deep X-ray therapy, both of which seemed to bring definite benefit. The sigmoid lesion which early in the disease showed a marked defect with spasm and retention (Fig. 11) gradually improved until about the time of discharge it looked practically normal. The patient has remained entirely well since. (Fig. 12.)

CASE III.—Miss B. C., forty-nine years old, came under observation after she had been ill for about nine weeks. She had been discharged from another hospital after a stay of seven weeks with the diagnosis of peritonitis of unknown origin, possibly pelvic. At the onset she had had general abdominal pain and vomiting with a temperature of 105°. She had gradually improved and had been discharged two weeks before she came under our care. She promptly got a recurrence and suffered intensely. When admitted to our hospital the severe pain had subsided and vomiting had stopped. Her chief complaint was pain in the right lower abdomen, whereas formerly it had been more on the



FIG. 11.                                    FIG. 12.

FIG. 11.—Large filling defect due to acute sigmoiditis. Was operated on and tumor liberated. No resection.
FIG. 12.—Same case two months later after drainage and X-ray treatment. Complete restoration of lumen.

left side. She was quite constipated. There was tenderness over the entire abdomen perhaps most marked over the region of the gall-bladder, associated with some rigidity. The pelvic organs seemed negative. There was general peritoneal irritation, but no indication of the primary seat of the infection. The temperature gradually came down. X-ray examinations were made, but did not lead to a positive diagnosis. No diverticulæ were observed. The probable diagnosis was inflammatory process right lower quadrant. Operation was performed because patient continued to complain of pain. A lower right rectus incision was made. There was some free fluid (cultured and later reported negative). There was evidence of an old general peritonitis in the form of dense adhesions. General exploration was done. No evidence of pancreatitis or perforated gastric or duodenal ulcer. Gall-bladder covered with adhesions, enlarged, thickened, and filled with stones. There was no evidence of perforation. The appendix was large, red, and hung into the pelvis where it was adherent. It was removed. The pelvic organs were matted together. No pyosalpinx, no evidence of tuberculosis. A

665

loop of lower ileum was adherent in the pelvis and so angulated as to cause incomplete obstruction. After separating it a perforation was found at the apex of the angulation. Whether this was entirely the result of manipulation could not be determined. It was considered that it might be an old perforation and the cause of the general peritonitis. (This was later disproved because no ulceration was found in the lumen.) The affected portion of gut, about 8 inches, was removed and an end-to-end anastomosis done. No other pathology found. Drainage was established and the abdomen closed.

The convalescence was uneventful. A sinus persisted for a long time and was later excised. She was well for about four years, when she developed severe cramp-like abdominal pain and vomiting. She was re-admitted five days after the onset. The abdomen was distended. A good-sized ventral hernia was present but was easily reducible and apparently not concerned in the symptoms. There was slight tenderness and rigidity over the entire lower abdomen, but on the left side there was marked tenderness and rigidity and an ill-defined tender mass. The temperature was 102.2°, pulse 108, white blood-cells, 17,500; polymorphonuclears, 85 per cent. A diagnosis of probable sigmoiditis was made. Conservative treatment was followed and in about ten days the temperature was normal. A barium clysma showed a long, narrow, channel in the sigmoid region which appeared to be due to spasm. No diverticulæ were visible. There was retention of barium.

An operation was performed, primarily to repair the ventral hernia, and secondarily to explore the abdomen. It was interesting to note that all signs of the old peritonitis had disappeared. There were no adhesions and the site of the end-to-end anastomosis could not be identified. A large, nodular, tumor was found in the sigmoid. It was red and apparently an acute sigmoiditis. No free fluid or pus present. Tumor not disturbed, but the hernia was repaired. The patient has remained well. It was considered that the original attack of peritonitis was secondary to sigmoiditis.

CASE IV.—Mr. M. L., seventy-five years old, was seen July 15, 1929, on account of suspected intestinal obstruction. His chief complaint was constipation and abdominal distension. He had not had a real movement for ten days. He had cramp-like pain and hiccough. The temperature was 99.6°, pulse 68. He had not lost weight. X-rays had been made a few days before. They showed very much distended large and small intestines. A barium clysma outlined very marked narrowing and deformity of the sigmoid. The abdomen was enormously distended and tympanitic, and one could see the outlines of the large loops of gut. No detail could be made out. Diagnosis of obstruction was made, probably due to carcinoma of the sigmoid.

A cæcostomy was done to give relief and allow more careful examination later. The gut was opened immediately and a large quantity of fluid, frothy fæces evacuated by suction. Hiccough stopped at once and the size of the abdomen diminished. There was a sharp febrile reaction for a few days. During the next few days drainage through the tube diminished, and fæces and gas began to be passed per rectum. Repeated X-ray examinations have been made since. There is no evidence of carcinoma. Barium clysma shows a peculiar irregular worm-eaten area at the junction of the descending colon and sigmoid, associated with a severe spastic condition of the colon which has been diagnosed as an inflammatory lesion. The patient has remained well with the cæcostomy tube in place. There is only a very little discharge. The bowels move well. An attempt was made some time ago to close the cæcostomy, but it resulted in a recurrence of the sigmoid symptoms and made reopening necessary. The age of the patient and his general condition make a resection inadvisable.

CASE V.—Mr. C. R. first came under our care in 1923, when he was forty-four years old. He complained of attacks of abdominal pain which he had been having for several years. The pain was at times quite severe, and localized in the left lower abdomen. There was no vomiting. There was always trouble with gas which seemed to stick on the left side. The bowels moved fairly well, but the stool was thin and ribbon-like of late. There had not been any blood. No loss of weight. Examination showed

tenderness over the lower left abdomen, no rigidity, no mass. A barium clysma was done and showed typical diverticulosis of the sigmoid and colon. (Fig. 2.)

Instructions as to proper hygiene were given and the patient was not seen again until three years later when he was admitted to the hospital with an acute abdomen. Symptoms had started two days before with severe sharp pain just above the bladder. There was no vomiting. Pain would come and go and at times had been severe. The abdomen was distended, and there was tenderness and rigidity over both lower quadrants. Rectal examination was negative. Temperature was 100.8°, pulse 96, white blood cells, 16,400; polymorphonuclears, 74 per cent. A diagnosis of peritonitis was made. In view of the known presence of diverticulosis, perforation of a diverticulum was considered as a likely cause. Operation was performed through a median incision. Loops of inflamed small intestines were found, but no free fluid. The appendix was red and was removed. The sigmoid was then exposed. In the upper part it looked fairly normal except for numerous diverticulæ filled with hard concretions. On following it downward free turbid fluid was encountered, which was cultured. The fluid surrounded a hard mass in the lower part of the sigmoid, about the size of a tangerine. After exposure it was found to be acutely red and the fat overlying it was œdematous. It was partly covered with fibrin. Adherent to it was a loop of small intestines, likewise covered with fibrin. The small gut was separated, but it was deemed wise not to disturb the mass for fear of opening a sealed perforation. A cigarette drain was placed on the outer side of the mass, and the omentum over the loops of small gut to separate them from the inflammatory mass. Abdomen closed around the drain. The culture showed colon bacilli and hæmolytic streptococci.

The convalescence was uneventful, but attacks of pain continued and increased in severity. At times they would last for hours. There was no vomiting, and no blood was noticed in the stool.

It was decided to do a resection. The operation was done in one stage, with an end-to-end anastomosis. The convalescence was stormy and was complicated by eventration and pneumonia. The final result has been very satisfactory.

CASE VI.—Mrs. M. E., sixty years old, was admitted a few months ago with the diagnosis of acute intestinal obstruction. She took sick about twenty-four hours before with severe cramp-like abdominal pain. She vomited only once. Had not passed gas or fæces. An enema had resulted in quite a hæmorrhage without any stool.

The abdomen was irregularly distended, partly due to a very large ventral hernia in an epigastric scar, through the covering of which active peristalsis was visible. There was no tenderness over the hernia and one got the impression that it was not concerned in the symptoms. There was a well-healed median scar below, and the entire lower abdomen was tender and rigid. There was suspicion of a mass. Vaginal and rectal examinations were negative. The patient had a temperature of 101.4°, pulse 96, white blood cells, 13,500; polymorphonuclears, 68 per cent.

An operation was done immediately without a positive diagnosis as to the cause of the symptoms or the position of the lesion. There was free fluid present which was cultured. (Later reported negative.) A hard, nodular, tumor could be felt in the pelvis. It was quite adherent. In order to gain access to it, several loops of small intestines which were adherent to each other and to the abdominal wall had first to be liberated. Some of these adhesions were old, while others were of more recent origin. The latter particularly involved the tumor and produced angulation and incomplete obstruction of the small gut. Further exploration then showed the tumor to be adherent to the bladder and surrounding structures. After liberating it and drawing it out of the abdomen it was found to be a tumor of the sigmoïd. It was somewhat red and partly covered with fibrin. It was very hard and apparently completely obstructed the lumen. Whether it was a sigmoiditis or carcinoma could not be stated. Resection was decided on and the first stage of a Mikulicz operation done.

After resection of the mass it was found to be an acute sigmoiditis with a per-

forating diverticulum which had formed an abscess in contact with the walls. Surrounding the opening of the diverticulum was a flat carcinoma, later reported gelatinous carcinoma. (Fig. 6.)

The patient is still under care but is doing well.

CASE VII.—Mrs. E. V. came under our care in 1916 when she was sixty-one years of age. Five years previously she had had a resection of the sigmoid done by one of my colleagues for what was supposed to be carcinoma but later reported sigmoiditis. An anastomosis had been done but on account of leakage, infection developed, requiring prolonged treatment and eventually a permanent colostomy. The colostomy functioned well. A sinus was present in one of the scars of the abdomen and led down to the rectal stump. The anus had contracted so that examination was not possible. Fluid injected into it escaped through the abdominal sinus. The patient's chief complaint was cramp-like abdominal pain associated with discharge of pus from the sinus. She was operated on and the sinus tract was completely excised down to the stump of the rectum which had been allowed to stay in. The gut was closed and the wound eventually healed. The anus was stretched to allow drainage downward. After this the patient was well until 1929 when she again began to have attacks of abdominal pain. At first they were attributed to the gall-bladder which was known to be filled with stones, but later the symptoms were more definitely intestinal in character. Gradually the pain became worse, and the patient felt as if gas stuck in the intestines and could not be expelled. Then tenderness developed over the lower abdomen to the inner side of the colostomy and after a while a mass became palpable. Carcinoma was suspected but exploration with a finger in the colostomy was negative, and an X-ray examination showed no deformity. The mass seemed to be situated between the lumen of the gut and the abdominal wall. Finally redness of the skin appeared and the tissues became very tender. Diagnosis of diverticulitis was made, probably with perforation, and operation advised. The gut was exposed for a considerable distance above the colostomy. The wall was hard and infiltrated but there was no free pus present, and no individual diverticulum was recognized. Drainage was established and a good recovery resulted. The patient has remained well since.

CASE VIII.—Mr. J. G., sixty years of age, was admitted to the Lenox Hill Hospital April 28, 1930, complaining of severe pain in the left lower abdomen and constipation. In the left lower quadrant, opposite the anterior superior spine a small, hard, elongated tumor mass was palpable, which was tender to touch. Rectal examination gave the feeling of an indefinite, somewhat smooth, evasive mass, which did not impress as an ulcerating lesion. With a history of recurrent attacks of pain for almost a year, which was so severe that he was unable to stand, with constipation for eight months, and the presence of a mass in the sigmoid region, a diagnosis of a surgical condition was made. He had no temperature but there was leucocytosis of 16,000 white blood cells, with 85 per cent. polymorphonuclears. We inclined to the diagnosis of sigmoiditis. X-ray examination showed multiple diverticulæ in the descending colon and the sigmoid. An irregular shadow suggesting a cavity connecting with the sigmoid was noted and was interpreted as a rupture of a diverticulum. (Fig. 4.)

At operation there was no free fluid. An inflamed sigmoid was found bound down in the iliac fossa. It was carefully separated and a culture made from the bed (later reported negative). After mobilization it was found that about 3 to 4 inches were involved in an acute inflammatory process which had led to marked thickening of the wall. In one place it looked as if a perforation had taken place but it had become plastered over with exudate. Resection was decided on and the first stage of a Mikulicz operation done. The affected portion of gut was removed ten days later. On opening it the lumen was found to be very small, but the mucosa looked normal. The perisigmoid tissue and the wall itself were very thick and infiltrated. Several incisions were made into this tissue and cultures taken. Pressure on the wall caused exudation

of thin pus, especially at one point representing the opening of a diverticulum which had perforated. A culture was made of this pus.

The patient made a good recovery and is well today. The following pathological report of the specimen was received:

*Microscopical Examination.*—"Sections obtained from various parts of the sigmoid show a congested mucous membrane which is largely denuded of epithelial covering and in several places shows small superficial erosions. The glands are usually enlarged and rich in goblet cells. The stroma in many places is more or less sclerotic and slightly infiltrated with inflammatory cells. Throughout the mucous membrane are small hæmorrhagic extravasations. The remainder of the wall shows considerable fibrosis. Just beneath the mucous membrane and involving the submucous muscular and outer coats is an irregular abscess lined with thick vascular granulation tissue which is densely infiltrated with inflammatory cells of all varieties and contains a number of foreign body giant cells. A very small part of this cavity is bordered by intestinal mucous membrane. In none of the sections examined is there observed a communication between the cavity and the lumen of the gut. The fat tissue attached to the outer surface of the specimen is involved in the chronic suppurative inflammation. Sections stained by the gram method fail to demonstrate the presence of microörganisms. There are observed, however, clumps of microscopic, round, blue staining bodies which may be gram-positive cocci."

The bacteriological findings were as follows: Cultures from pus of diverticulum.—*Bacillus enteritidis.* Cultures from incisions in wall of sigmoid.—*Staphylococcus albus and diphtheroid Bacillus.* There were no anaërobic organisms present.

*Comment.*—A group study of acute sigmoiditis and diverticulitis calls attention to the seriousness of this condition. It reveals that diverticulosis, as such, is not an innocuous lesion. Once recognized in a patient the physician or surgeon assumes a serious responsibility if he allows the patient to depart without warning him of possible danger and instructing him in the known means at our command to avoid complications. Many of the details of the long-drawn-out treatment in several of the cases in this series have been omitted, but it may safely be said that it is difficult to imagine a group of patients that tax a surgeon's judgment, ability, and patience, to a greater degree than these complicated cases of diverticulitis.

## REFERENCES

[1] Haines, Willard D.: ANNALS OF SURGERY, vol. lxxxv, p. 84, 1927.
[2] Newton, Francis C.: Harvey Cushing Number, p. 1339, 1929.
[3] Mayo, William J.: ANNALS OF SURGERY, vol. xcii, p. 739, 1930.

# TREATMENT OF MEGALOCOLON BY SYMPATHECTOMY

By David E. Robertson, M.D.

of Toronto, Canada

A STUDY of the clinical cases of megalocolon shows the fact that this condition is not because of atonia or lack of power and development of the musculature of the colon. Cameron,[1] among others, has described the anatomic condition of the wall of the large gut, the increase in hypertrophy of the longitudinal and to a greater extent the circular muscle fibres. It is observed also that the dilatation of the colon is always greater on the left side. In some cases, indeed, it is present only in the descending limb of the large intestine. In those cases where local excisions have been done of an enlarged loop of bowel, the commonest sequence is to have an enlargement form in the bowel replacing the loop. In one case I reported[2] the patient had had three operations, at each one of which loops of dilated large intestine were removed. This experience has been the not uncommon one following operations at which part or all of the large intestine has been removed for the cure of megalocolon.[3] One is, therefore, justified in concluding that operative procedures of this type do not cure the condition, and in addition it is obvious that the factor producing the dilatation is left still in existence. Its causative factor, therefore, cannot be something inherent in the wall of the dilated bowel. It would appear from this that the condition is really one of obstruction, not complete and constant, but incomplete and intermittent. Clinically this has been observed.

Brennemann[4] and David[5] describe the condition associated with congenital strictures of the rectum.

Fullerton[6] believes that the pelvi-rectal sphincter is the factor in producing obstruction and quotes Hurst and the theory Hurst advanced of achalasia, that is, an absence of the normal relaxation of sphincters, in this case the pelvi-rectal or anal sphincter. Sphincter spasms are known elsewhere as in cardiospasm and pylorospasm, and Fraser[7] describes the condition as due to a neuromuscular error resulting in "an uncontrolled function, a delay in acquisition of the power of inhibition combined, it may be, with achalasia and insufficient relaxation of the associated sphincters."

A case herein reported shows the progressive enlargement of the colon in the time he was one and one-half to two and one-half years of age. During this time the capacity of the colon was much increased, as is shown in Fig. 1.

Hirschsprung's disease is described as a congenital dilatation of the colon, but if such a condition exists it must be very rare, as most of the cases that are followed closely are found to be of the type that are obstructive in origin. It is true that the majority of the cases of megalocolon that are

found in the young date their symptoms from birth or very soon after birth, but no one has shown or proved that infants have large hypertrophied colons at or soon after birth. It would probably be an improvement in nomenclature if the term "congenital idiopathic dilatation of the colon" were dropped. The very anatomic fact of hypertrophy must surely denote an obstructive lesion lower down that makes necessary the hypertrophy in an endeavor to overcome it.

The surgical procedures that have been devised in the past for the correction of this condition by a direct attack upon the enlarged colon have given a high mortality, and those cases that have survived the operation have for the most part been failures in relieving the condition. Medicinal means have provided nothing approaching benefit. Means designed at dealing
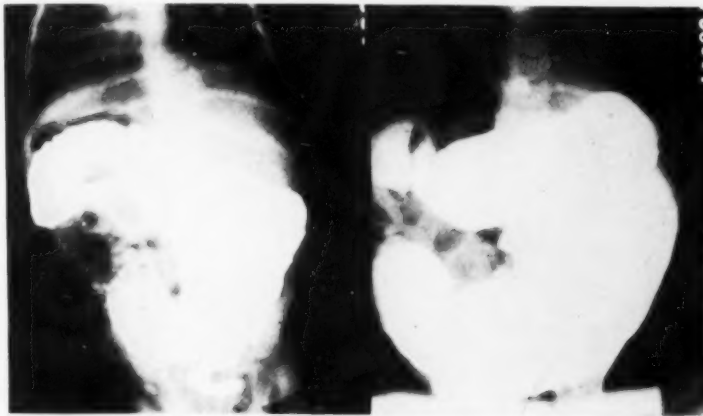


FIG. 1.—C. T. X-ray of barium enema. August, 1929, aged ten months. October, 1930, aged twenty-two months.

with the anal sphincter by stretching have been reported by Fullerton and others. There are reports of successful treatment by division of the sphincter of O'Bierne.

Since the application of original lumbar ramisection of Royle to this disease there has been an outstanding number of cases reported as cured. Wade[8] has reported recently fourteen cases. Judd and Adson[9] Rankin and Learmouth,[10] and others have reported a successful series.

Royle's[11] original contention was that the rami running mesially to join the hypogastric carried the fibres that maintained the spasm in the sphincters. He advocated the division of these mesially directed rami. He has done this type of operation in many cases since for the relief of constipation in cases other than megalocolon, and has reported cures.

Rankin and Learmouth presented to this Association last year in Philadelphia a paper wherein they described the division of the presacral nerve with the division of the rami from the lumbar ganglia. This is a transperitoneal operation. This operation is extremely interesting from an anatomic standpoint as well as from a practical one.

671

The procedure that we have followed has been to attack the lumbar sympathetics from the lumbar approach, and we have recently removed the whole trunk from the second down to the level of the fourth. This has produced in patients, in addition to the changes in lower bowel function, two grateful changes, *viz.*, warm feet and dry feet, and no deleterious effects have yet been manifest from this proceeding. The operation of the approach through the flank, as recommended by Royle, is readily done and is undoubtedly rendered more easy by the use of spinal anæsthesia. After the flank incision the peritoneum is pushed forward and the sympathetic cord is readily felt lying on the anterior aspect of the lumbar bodies. In one case only of megalocolon have we done a bilateral operation, but in lumbar sympathectomies for vascular diseases of the extremities many cases of



FIG. 2.—M. F. K., 1931. X-rays of barium enema. September, 1927–March, 1931.

bilateral operation have been done at the one visit to the operating room. The operation is, strangely, devoid of shock.

I have recorded the details of three cases of megalocolon treated by ramisection and ganglionectomy.[2] These three cases have continued well. One case operated upon in 1927 is having a normal bowel-movement history. (Fig. 2.) (M. F. K., February, 1931.) Another case, operated upon in 1929, had a relapse from the normal, but she was a child who came from a home that was altogether disorganized, the father in jail and the mother irresponsible. After a "clean-out" she is, however, having again normal movements. The third case, of a woman of thirty, who had, previous to double lumbar ganglectomy, had an appendectomy and three local excisions, reports after the experience of sixteen months no difficulty with movements. The volumetric change in the enema she could tolerate changed from 120 ounces to fill the sigmoid and ascending colon before operation, to 80 ounces to fill the entire colon two months after operation. This case showed a marked improvement in the haustra of the cæcum, and the right side was operated upon.

Three additional cases are here reported in detail.

CASE I.—C. T., aged twenty-two months, October 29, 1930. Patient in hospital six months ago, complaining of constipation, since when he has had consistent medical treatment but there has been no improvement in his constipation nor general condition. Abdomen has been getting progressively larger. Patient has been vomiting more frequently than previously, two to three times a week. After eating vomits practically everything taken. Has failed to gain and is quite weak and suffers from lassitude. The baby is a well-developed and well-nourished white male child; does not appear acutely ill.

*Digestive System.*—Buccal mucous membrane clear, tonsils present, throat not inamed, pharynx is quite normal, abdomen is a large, distended, soft abdomen which is not rigid in any area, no tenderness, no masses can be felt, liver, kidneys and spleen not palpable. He is quite coöperative at examination, appears quite intelligent and does not cry or become the slightest bit irritable at examination. *Other Systems.*—Normal. *Provisional Diagnosis.*—Hirschsprung's disease.
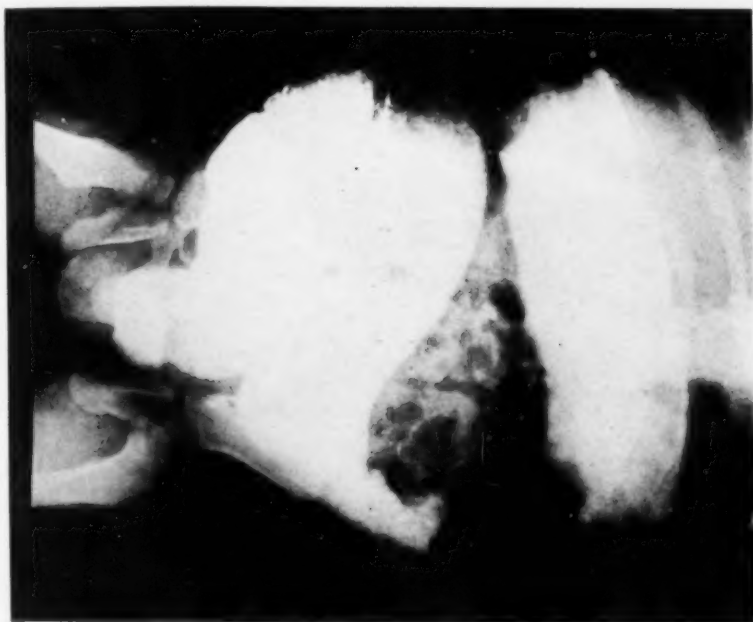


FIG. 3.—C. T. X-rays of barium enema one month after operation.

*X-ray Report.*—October 3, 1930. A barium enema was given today and the colon was shown to be markedly dilated throughout its whole length. Its dilatation was much greater than that shown on examination on November 20, 1929, and is most marked in the sigmoid loop, which is both long and very capacious. The case appears to be one of Hirschsprung's disease.

*Operation.*—October 29, 1930. An incision was made in the left flank, and, the peritoneum being pushed forward, the sympathetic trunk was exposed as it lay on the vertebral bodies. The white ramus from the second lumbar ganglion was identified and divided. The entire cord below this was removed.

Following the operation his recovery was uneventful. He was given an enema daily for the ten-day period he was in hospital and this was sufficient to give him a daily movement, and when he was last seen on May 31, 1931, he was having six to eight spontaneous movements a week. (Fig. 3.)

CASE II.—B. F., aged two and one-half years, July 25, 1929. Has been constipated since six months. Laxatives had no effect. Enema daily; followed by a movement

half to one hour later. Cries as if in pain, pulls hands and feet up. Magnesia caused small watery movement. Since the beginning, July, 1927, the fecal discharges have always been well formed. Hard at first, now slightly softer. This has persisted throughout. *Mucus.* Recently, last two months, comes before movement. Greenish tint, small amount. *Color.*—Changeable, occasionally very dark green, almost black. Sometimes clay color, exceptional. *Odor.*—Very foul-smelling always. Has undigested food in stool sometimes. Mother claims that child masticates food thoroughly. Lasted first few weeks of constipation only. Child otherwise has been very healthy. *Sleeps.*— Well for last eight months, at first restless and irritable. *Appetite.*—Very poor. *Bowels.*—Constipated. *Pains.*—Over abdomen, irregular. Cries a lot with them. Occur with a movement. Also very irritable.

The patient is a well-developed, well-nourished boy, not actually ill. Tongue coated. Buccal mucous membrane is clear. Teeth in fair condition. Tonsils are small and cryptic. Pharynx is not congested. Abdomen is full, rounded and soft. Colon is palpable the whole distance from the right lower quadrant down to the sigmoid. It contains a large amount of fecal matter, particularly the sigmoid, which is palpable in a large moveable mass in the pelvis. The colon does not appear to be dilated and
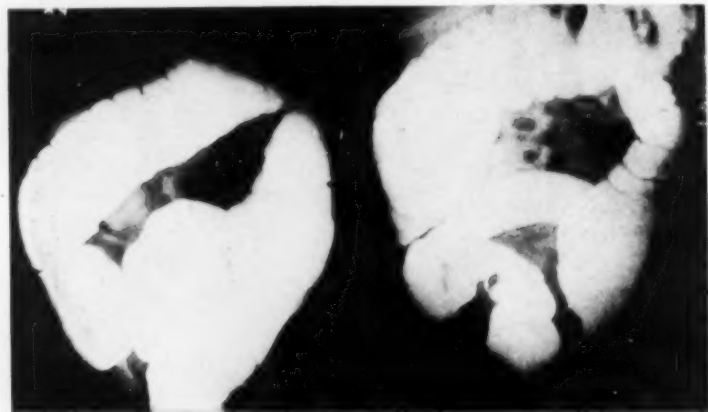


FIG. 4.—B. F. Two on one slide. July 10, 1930. September 15, 1930.

is about normal in size. Transverse is above the umbilicus and not apparently displaced. It can be observed to move with respiration. Liver, kidneys and spleen are not palpable. No other masses. No tenderness. No meningeal signs. No apparent motor or sensory defects. Intelligence apparently normal. *Diagnosis.*—Hirschsprung's disease.

After being in hospital two weeks he was sent home to have medical treatment, July 6, 1930. Again admitted to hospital. Has not improved since leaving the hospital.

*Special Examination.*—Abdomen. Abdomen is distended in appearance, but moves freely on respiration. The note on percussion in the upper part is resonant, the lower part shows dullness. There are masses felt in the lower portion of the abdomen. These masses can be indented and are putty-like in consistency. By rectal examination large masses could be felt in the lower bowel which were fairly firm in consistency but of putty-like consistency.

*Operation.*—July 16, 1930. A left-sided lumbar ganglionectomy through a flank incision.

Following this the child had, while in hospital, enemas, but within a month had daily spontaneous movements. The colon was materially changed, as evidenced by X-ray of barium enema. Haustra were well marked and girth smaller. Moreover, the giving of enema caused pain, whereas it was formerly born without discomfort and

674

the colon had tolerated large quantities. (Fig. 4.) Eleven months have passed since his operation and he remains well.

CASE III.—L. S., male child, aged three years, June 10, 1930. Since birth child has had constipation and inability to move bowels. Goes about a week without any bowel movement and the abdomen becomes greatly distended. Complains then of pain and there is a watery discharge from bowels. When bowels move large amounts of fæces are passed and distention disappears, also the pain. No vomiting. Has had "bowels stretched" at clinic. Abdomen greatly distended. Large hard swelling in region of cæcum on right. Rectal examination shows lower bowel densely packed with fæces.

*Special Examination.*—Abdomen is considerably distended, much larger than normal, distention is not entirely tympanitic, just partly so. The abdomen moves fairly freely on respiration. On palpation there are no areas of rigidity or of marked tenderness. There is considerable swelling in the region of the cæcum and the whole of the abdomen is large in size and fairly firm to pressure. The swelling in the region of the cæcum and in the left lower quadrant of the abdomen has a putty-like consistency and can be indented, on deep pressure. Rectal examination shows the lower bowel markedly distended with fæces. There is no marked tenderness on rectal examination.
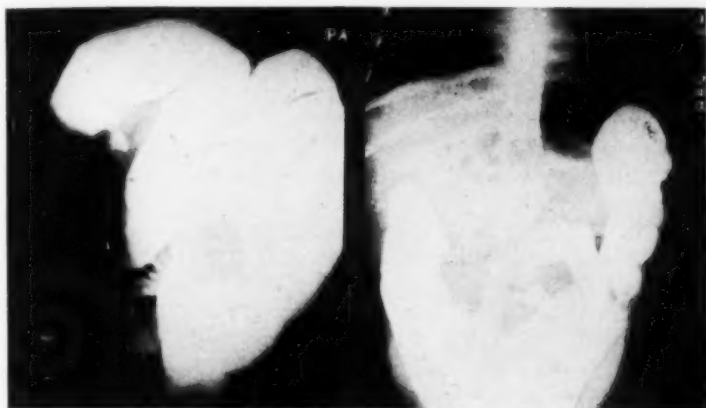


FIG. 5.—L. S. Two on one slide. July, 1930. June, 1931.

*Operation.*—June 17, 1930. Under general anæsthesia of ether, vertical incision was made from the margin of the twelfth rib in the left side downwards and then curving forward along the crest of the ilium. Subcutaneous tissues and part of the latissmus dorsi were incised. Fingers were inserted to separate the peritoneum from fascia covering psoas muscle. The peritoneum and intestines were then retracted forward and by means of palpation the sympathetic trunk was located and dissected out and a section removed including the second, third, and fourth lumbar ganglia. Wound was then closed in layers with chromic catgut and horsehair. Condition remained good throughout.

Prior to operation this boy had in one morning fifteen enemas. These were just sufficient to clear the colon. Following his operation for a period of two weeks he was given daily enemas. He was put on liquid paraffin and began to have one or more movements every day, a condition that is still present, just one year after operation. X-rays of barium enema July, 1930, to June, 1931, show a remarkable difference. (Fig. 5.)

The experience of these cases leads one to believe that the constipation associated with megalocolon can be cured by a left-sided lumbar sympathectomy. In all cases here reported the patient either has spontaneous movements or has been rendered so that the slightest exhibition of medication

675

is sufficient to produce a resumption of normal habit. These cases, if not carefully supervised by those in charge of them, may develop the bad habit of neglecting to have regular defecation. Yet these are readily returned to a daily habit again. The administration of a barium enema at periods following operation gives ample evidence to the administrator of the reduced size of the colon and the spasm that is easily induced in the colonic wall. Colons that would, prior to operation, tolerate large quantities of enema, some time after operation suffer pain and a desire to expel when only a small quantity is introduced. The diminution in the size of the colon following operation takes some months to become marked. The presence of haustrations is likewise more marked as time elapses. Bowel function may show no marked improvement for some weeks. It is probably advisable to have daily enemas given following operation for the period the patient is in bed. After this period the patient may well be left to have spontaneous movements.

## REFERENCES

[1] Cameron: Arch. Dis. Child., vol. iii, p. 210, 1928.

[2] Robertson: Can. Med. Ass. Jour., vol. xxiv, pp. 359–364, 1931.

[3] Lord Moynahan: Personal Communication.

[4] Brennemann, Joseph: J.A.M.A., vol. lxxxix, No. 9, August 27, 1927.

[5] David, V. C.: Surg., Gynec., and Obstet., vol. xxxvii, pp. 197–201, August, 1923.

[6] Fullerton, Andrew: Brit. Med. Jour., p. 3459, April 23, 1927.

[7] Fraser, J.: Brit. Med. Jour., vol. i, pp. 359–364, 1926.

[8] Wade: Med. Jour. Austral., vol. i, p. 456, 1927.

[9] Judd, and Adson: Trans. Am. Surg. Ass., vol. xlvi, p. 159, 1928.

[10] Rankin, and Learmouth: Trans. Amer. Surg., pp. 279–289, 1930.

[11] Royle: Med. Jour. Austral., vol. i, p. 136, 1927.

# TOTAL COLECTOMY; ITS INDICATION AND TECHNIC

By Fred W. Rankin, M.D.

of Rochester, Minnesota

from the division of surgery, of the mayo clinic

The frequency of occurrence of single or multiple polyps of the large bowel and rectum is in direct proportion to the care and assiduity with which one seeks them. They are almost always demonstrable in resected specimens from operations, in the mortuary or by proctoscopic examination. Their size and number are so variable that one may frequently experience difficulty in satisfactorily demonstrating tumor, and yet, in most instances, one readily makes out single or multiple polyps, varying in size from small protuberances of the mucous membrane, which histologically are of true polyp formation, to the diffuse lesion commonly recognized as the "polyadenomes en nappe of Menetrier or as the polypoidosis of Broders.

My interest in polyps of the colon has been markedly stimulated recently by the study, with FitzGibbon, of thirteen cases in which we were able to demonstrate, to our own satisfaction at least, that there was no break in the sequence of steps from hyperplasia of the polyp type of growth to malignant change. This work so closely parallels the work of Wechselman, Schmieden, Hauser and others, that the intriguing theory of the universal development of carcinoma of the colon from polyps forces itself on one's attention. Although this hypothesis is undoubtedly vulnerable, its apparent truth in a high percentage of cases demonstrates that one may not disregard the use of extremely formidable procedures in combatting conditions which definitely are shown to become malignant.

In the files of the Mayo Clinic are records of sixteen cases of total or subtotal removal of the colon. I have divided these arbitrarily into two groups, depending on the amount of bowel removed at operation, since the indications have been assumed to be similar in each instance. As subtotal colectomy I designate removal of the colon down to, or almost to, the juncture of the sigmoid with the rectum, whereas the term total colectomy is used to indicate complete exeresis of the colon, sigmoid and rectum. There is disagreement in the literature as to whether removal of merely the large bowel, leaving the rectum, should not be called total colectomy, but it is the latter group, in which the entire colon and rectum have been extirpated, that I wish to call to your attention in reporting six cases in which the operation has been done within the last three years for definite organic lesions. Such a formidable procedure as this, obviously, should not be undertaken lightly, and distinct indications should govern its selection.

There are two general types of conditions which call for total colectomy: A definite primary lesion, and a secondary lesion. The term "polyposis" has

been used to designate the primary type of lesion, but I agree with Erdmann that "diffuse adenomatosis" is a better and more satisfactory term, and with Broders that "polypoidosis" is a much more descriptive pathologic term. Polyposis, for instance, may mean only two polyps, either sessile or pedunculated, or any number of polyps of the colon. Polypoidosis, on the other hand, indicates that the entire lumen of the large bowel, from the anus to the cæcum, is studded with projections which raise the surface of the intraluminary portion of the bowel, and between which there are small strips of normal mucous membrane giving it the appearance of many convolutions, as in the brain. The secondary lesion is advanced, complicated, chronic ulcerative colitis which, in some of its ramifactions, acts as focal infection or produces pseudopolyposis, which is, in itself, a potentially malignant condition, or at least, in my experience, malignancy has occurred simultaneously with it.

Polyps of the large bowel generally have been treated as a single genus of tumor and have been described anatomically as pedunculated or sessile growths, varying in size, shape and consistence, with an underlying papillary or adenomatous structure. Many authors have classified these growths according to some etiologic factor, such as dysentery, ulcerative colitis, hyperplastic tuberculosis, or non-specific affections of the large bowel. Again, the clinical manifestations, particularly as regards diffuse adenomatous types of polyps, have caused them to be classified as of the adult or acquired type, and of the congenital or adolescent type. Unquestionably, the presence of polyps, occasionally single but frequently multiple, in the colon and rectum, is of grave significance in relation to the ultimate development of carcinoma of this organ. Furthermore, polyps occur in the large bowel and rectum four times more often than in other portions of the gastro-intestinal tract. Their presence in the rectum, rendering them particularly accessible to study, and in resected colons, has caused me to undertake evaluation of their relationship to carcinoma, on the basis of histologic study, without regard to the etiologic factor involved.

Anatomically and pathologically, there are two general types of polyps in the colon, one of which is a true neoplasm, the other the result of an inflammatory reaction. One form of the true neoplastic or congenital type of this condition has been designated by Erdman as "diffuse adenomatosis" and I am inclined to think this term, or "polypoidosis," or "polyadenomes en nappe," as Menetrier designated the condition years ago, would be preferable. The other form in the colon, of the congenital type, may be present either as one or two discrete tumors, or as discrete tumors which involve the entire mucosal surface of the bowel from the anal canal to the ileocecal coil, and is, in reality, more of a true neoplastic condition as compared to polyadenomes en nappe or polypoidosis. Both usually occur in families and the former is known to undergo malignant change in from 40 to 50 per cent. of the cases. In this form, small, raised elevations of the mucous membrane a few millimetres in diameter may occur, or the elevations may be scattered

throughout the entire bowel and may be represented by all sizes up to and including large, pedunculated tumors, which are several centimetres in diameter. Occasionally tumors sufficiently large to cause intussusception and obstruction have been found. Under the term polyadenomes en nappe Menetrier recognized in the stomach glandular hypertrophy that caused great thickening of the mucous membrane, but differing from polyadenomes polypeux, he thought, in that the glands were increased in height but preserved most regularly their vertical direction. Their length was increased five to seven times, whereas their breadth varied from slight increase to actual diminution. On the other hand, he considered the pathologic picture of polyadenomes polypeux as similar to polyadenomes en nappe. He thought that the glands were less markedly changed in their various diameters than in polyadenomes en nappe, and that the inflammatory reaction, as represented by the round-cell infiltration and increase in connective tissue, was a much more prominent feature. He believed that the two types, therefore, might be considered as similar, in that they represent mucosal hypertrophy. It is reasonable to believe that whether single tumors or multiple tumors in the large bowel are of congenital origin or are the result of an inflammatory lesion in the bowel, when they reach a point in their growth at which they may be called polyps, the metamorphosis into carcinoma is identical.

*Polypoidosis: the first indication for total colectomy.*—FitzGibbon and I traced thirteen cases of multiple polyps of the colon through the sequence of events from a benign to a malignant condition. Forty years ago, Hauser, excluding all growths having a possible inflammatory background, proposed that polyps be grouped according to the amount of degenerated epithelium in them. Wechselman, in 1909, devised a three-phase scheme of classification, limiting his critical analysis to the epithelial elements of the tumors, whereas Schmieden and Westhaus, in 1927, by introducing the relationship of selected attributes in the connective-tissue framework, formation of pedicles, and macroscopic appearance, rendered the Wechselman criteria more useful. Reviewing the histopathologic characteristics of the polyps in our cases, we were able to show conclusively that they were not all of a piece, and that those in this series definitely proceeded from benignancy to malignancy. The polyps are divided into three distinct groups, varying grossly as well as microscopically.

In Group 1 the epithelial elements are practically normal; the tumors are rough nodules on the mucous surface of the bowel, varying from tiny clubs to masses 2 centimetres on gross section. It is conceivable that this type of polyp may become malignant, but there is small evidence that it has any more tendency to such change than normal mucous membrane.

The polyps of Group 2 are easily distinguished from the foregoing, and the structural changes in both the epithelium and connective-tissue elements are abrupt and striking. The epithelium fails to differentiate into normal intestinal mucosa. The cells are elongated, and, by their increased bulk, compressed laterally. They may be arranged in single rows, but frequently

are pushed into multi-layered buds which project into the lumens of the tubules, but more often into the connective-tissue matrix. The nuclei are elongated, take stains deeply, and give to the proliferating tissue a darker color. As this epithelial proliferation progresses, there is a complimentary response in the connective tissue of the muscular and submucous coats, which produces a stalk. The pedicles are large or small, according to the rapidity of the proliferation. I feel that the tempo of the development of the carcinoma in polyps is an extremely important factor in their metamorphosis.

In Group 3, the epithelium is almost completely undifferentiated. It is an accentuated form of that seen in Group 2. The development of the epithelial proliferation, which outpaces that of the connective tissue, results in a polyp which is of complex histologic structure. Grossly, the polyps of Group 2 may attain large size and age, whereas those of Group 3 rarely do, becoming early, I believe, deep, infiltrating carcinomas.

This congenital type of polypoidosis, recognized, as it is, as a precursor of malignant growth in a high percentage of cases, is not an exceedingly rare entity; Bargen gives its ratio to the acquired type as approximately 1 to 4. The congenital or adolescent type manifests itself in young persons by profuse rectal hæmorrhage and diarrhœa, associated with concomitant anæmia, and occasionally with acute intestinal obstruction. This disease was first described by Virchow, in 1863, as "colitis polyposa," and Cripps, reviewing three cases which occurred in one family, shed more light on the subject in 1882, when he described accurately the conditions which is designated as polypoidosis. Cripps' first patient, a man aged twenty years, had had symptoms for ten years, and polyps had been removed by way of the rectum with only temporary relief. This patient succumbed suddenly, and post-mortem examination disclosed that death was due to adeno-carcinomatous stricture of the sigmoid, which occurred in the presence of diffuse, pedunculated polyps. Subsequently, Cripps reported two other cases, those of a brother and a sister of the first patient, aged seventeen and sixteen years, respectively.

One patient on whom I performed total colectomy had a sister who died at the age of twenty-eight years with multiple polyps of the bowel, and a brother is now being treated at the clinic for multiple polyps of the bowel; at this time the brother is resting between stages of operation for removal of the entire colon.

Erdmann's two patients were youths aged fourteen and sixteen years. Neimack, I believe, reported the case of the youngest patient on record, that of a girl aged twelve years, who had had symptoms for three years.

The diagnosis of congenital polypoidosis is usually made by digital or proctoscopic examination, because the polyps invade the rectum as well as the entire colon, and are both palpable and visible, even on cursory examination. Röntgenograms, especially those made by the combined method of Fischer, in which an opaque enema is followed by rectal injection of air, are especially accurate in interpretation of the presence and distribution of polyps. Usually the entire bowel is studded with small tumors, interspersed among

which are tumors sometimes as large as 3 centimetres in diameter, attached to a slender pedicle. Depending on the number of tumors, normal mucosa will appear in the lumen of the bowel, but in one of the cases the tumors were so diffusely scattered that scarcely any normal mucous membrane was visible. Usually they had a narrow pedicle with a clubbed head, and the larger tumors occasionally had extruded through the rectum, or had been broken off higher in the intestinal canal.

The two especially interesting phenomena associated with this ailment are the pathologic characteristics of the lesion, which can be traced directly through the various stages of hyperplasia to malignant change, and the formidable surgical procedures involved in extirpation. Clinically, an acute
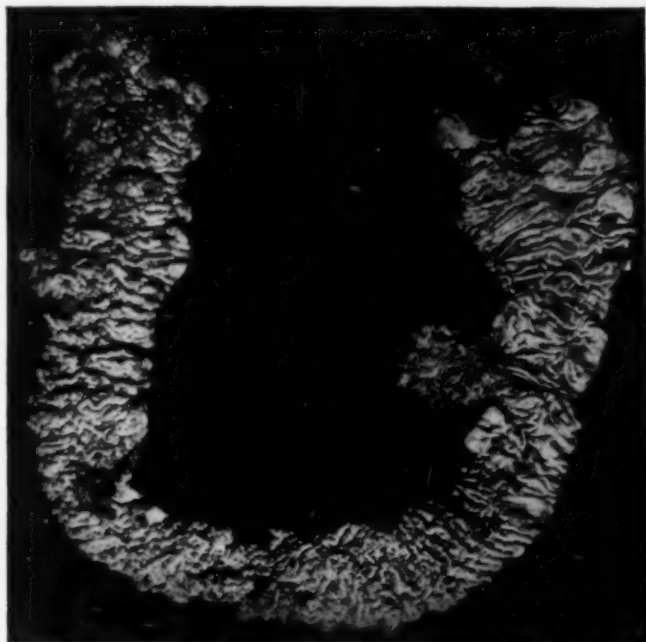


FIG. 1.—Multiple polyps of the entire colon, showing several large, pedunculated polyps.

abdominal catastrophe may first call the patient's attention to the presence of polyps, which usually means that the condition is widespread, and involves not only the large bowel but occasionally the small bowel. One patient on whom I performed partial colectomy for multiple adenomas had undergone three operations elsewhere for acute obstruction due to intussusception of the small bowel; the exciting cause in each instance was a large, pedunculated polyp. Polyps had also been removed from the stomach and cæcum, but in none had malignancy been suspected.

The following abstracts of cases of congenital polyposis illustrate the pathologic structure present and the surgical technic utilized.

CASE I.—A woman, aged thirty-two years, was admitted to the clinic with the complaint of "mucous colitis." She gave a history of having had dysentery for eight months.

This was evidenced chiefly by five or six passages of mucus and fecal material in twenty-four hours; blood was never observed in the passages. Her general condition was good; appetite, digestion, and weight were maintained.

Examination revealed that the patient was asthenic and anæmic but gave no evidence of loss of weight. Polyps were noted on digital examination, and on proctoscopic examination the rectum and sigmoid were seen to be studded with polyps. Tissue from one polyp was characteristic of adeno-carcinoma, graded 2. Examinations of stool did not give evidence of ulcerative colitis. Röntgenologic examination demonstrated multiple polyps of the entire colon. The concentration of hæmoglobin was 68 per cent., and erythrocytes numbered 4,480,000.

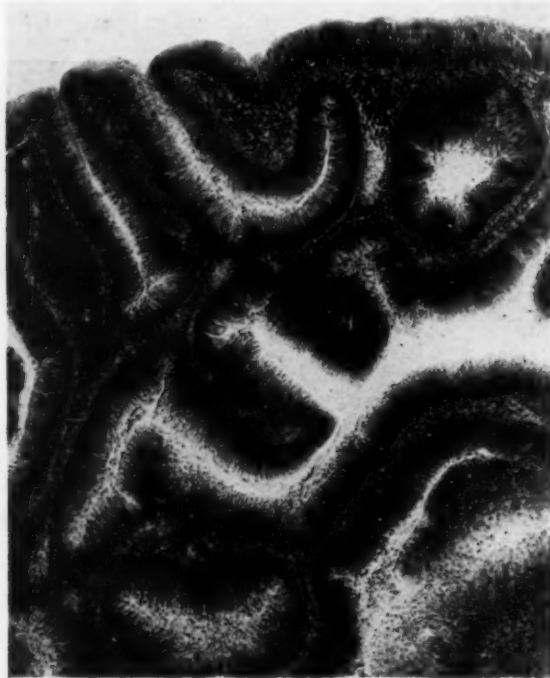November 26, 1928, ileostomy was performed; June 20, 1929, partial colectomy was



Fig. 2.—Polyposis of the colon, showing tendency toward attenuation of cells.

performed, the rectal stump being turned in and placed retroperitoneally; and July 3, 1929, the rectal stump was resected posteriorly.

Pathologic examination disclosed multiple polyps throughout the colon and rectum (largest 4 centimetres, near the cæcum) (Figs. 1 and 2); one pedunculated polyp in the transverse colon (1 centimetre); one pedunculated hæmorrhagic polyp in the descending colon (1 centimetre); one pedunculated polyp in the sigmoid (3 centimetres); innumerable small polyps, and one adeno-carcinoma, graded 2, involving a polyp in the rectum.

The patient died April 19, 1930, eleven months after the third stage of the operation was completed.

CASE II.—A woman, aged twenty-five years, was admitted to the clinic with a history of having had diarrhœa since childhood. Up to three years prior to admission she had had four to five stools daily, but since then had had as many as eight and ten. At first blood appeared in the stool frequently and, more recently, was noted every day and in increasing quantity. Polyps often protruded from the anus. Her general condition,

appetite, digestion, maintenance of weight and strength were satisfactory. She appeared to be well developed and but slightly undernourished. There was no loss of weight.

General examination proved negative except for the finding of multiple polyps on rectal examination. Röntgenologic examination revealed multiple polyps, with evidence of malignancy in one area. Proctoscopic examination disclosed multiple polyps involving the bowel as far as could be seen and adeno-carcinoma graded I involving one of the polyps in the rectum. The concentration of hæmoglobin was 62 per cent.

October 28, 1929, ileostomy was performed; January 23, 1930, colectomy was performed leaving the rectal stump, which was placed retroperitoneally, and February 6, the rectal stump was r e s e c t e d posteriorily.

Pathologic examination disclosed six pedunculated and sessile polyps (Figs. 3 and 4), two of the largest pedunculated ones showing beginning carcinoma (Fig. 5) (6 by 3 by 3.5 centimetres, and 3.5 by 2.5 by 1.5 centimetres) ; and innumerable small polyps extending from the ascending colon to the rectum.

The patient recovered satisfactorily and is living and well.

CASE III.—A man, aged thirty years, was admitted to the clinic September 26, 1930, because of diarrhœa. His father, mother, three brothers, and a maternal aunt had died of carcinoma of the large bowel, and a sister had died of carcinoma of the uterus. He had a history of attacks of summer diarrhœa, the first of which had occurred in 1922 ;others had occurred in 1923 and 1925. The attacks lasted two to three months and were attended by an average of ten daily rectal discharges of fæces, mucus and blood. After May, 1928, he was never completely free of diarrhœa and some abdominal discomfort. He underwent considerable treatment for "spastic colitis," "amebic dysentery," and "mucous colitis," and at one time or another took emetine, quinine, thymol, yatren and stovarsol, without apparent relief.

On examination, the patient proved to be somewhat undernourished and ten pounds under normal weight. There was moderate tenderness in the lower part of the abdomen.



FIG. 3.—Multiple polyps of entire colon; beginning carcinoma in large, pedunculated polyp.

Proctoscopic and röntgenologic examination disclosed multiple polyps. (Fig. 6.) The concentration of hæmoglobin was 63 per cent., and erythrocytes numbered 4,380,000 in each cubic millimetre of blood.

October 7, 1930, ileostomy was performed; February 20, 1931, partial colectomy was performed to a point near the rectosigmoid juncture, and April 3, 1931, combined abdominoperineal resection of the rectal stump was done.

Pathologic examination disclosed multiple polyps throughout the colon and rectum,
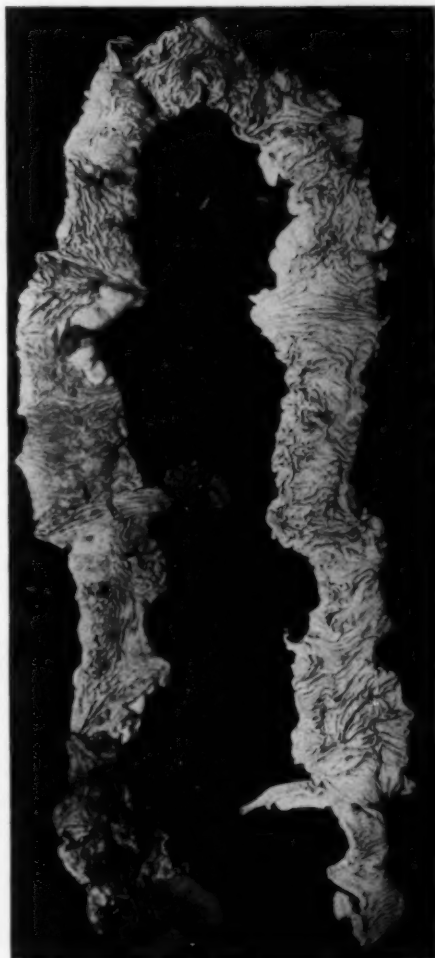
FIG. 4.                                    FIG. 5.

FIG. 4.—Single polyp of colon.
FIG. 5.—Carcinoma of sigmoid in a case of multiple polyps of the colon.



FIG. 6a.                                   FIG. 6b.

FIG. 6a.—Polyps obscured by barium-filled colon.
FIG. 6b.—Röntgenogram of colon by Weber's modification of Fischer's method, showing sessile polyp
in descending colon, and pedunculated polyp in distal part of transverse colon.

and many pedunculated and sessile adenomatous polyps, the largest, 2.5 centimetres. (Fig. 7.)

The patient recovered satisfactorily.

*Complicated chronic ulcerative colitis and sequelæ. The second indication for total colectomy.*—The second indication for total colectomy is complicated chronic ulcerative colitis, producing either multiple lesions of the joints as a focus of infection, or resulting in the formation of multiple polyps, which may, and not infrequently do, change into malignant growths. The three patients on whom I performed total colectomy following chronic



FIG. 7.—Multiple polyps of entire colon.

ulcerative colitis of long standing had all been suffering from the effects of absorption from a useless, infected, foul large bowel, containing pus, with resulting multiple arthritic lesions or multiple fistulas, or both. In these cases, all efforts at medical treatment had been only partially successful, and in two of the cases preliminary ileostomy had been done more than a year previously because of the apparently hopeless outlook without sidetracking of the colon.

In reviewing these three cases, it was obvious that the technical difficulties, although more complicated than those encountered in treating the congenital variety of polypoidosis, were not made unsurmountable by formation of abscesses, or firm fixation or infection, and the tendency to subsequent

peritonitis was not a formidable objection. The already existing immunization unquestionably was of great advantage in these cases, and although, in the first colectomy in this series, I broke into an abscess in the glands around the cæcum, there was little reaction following the operation and the patient made an uninterrupted recovery.

Besides the unhappy sequel of long-standing chronic ulcerative colitis, resulting in complications, the superimposition of malignant disease on the polyposis which is secondary to the colitis is important. That this is not unique, although it does happen infrequently, is attested by the fact that in more than 1,100 cases of ulcerative colitis, complicated and uncomplicated, seen at The Mayo Clinic, in twenty-five cases carcinoma has developed in the presence of the polyposis which was caused by the inflammatory lesion. Although perhaps it is impossible to prove pathologically that these carcinomas developed as direct sequelæ of events of the inflammatory process, I think it is a reasonable conclusion that if chronic irritation of long standing initiates carcinomatous changes in a viscus, complicated, progressive, ulcerative colitis of long standing is a factor in malignancy.

The production of multiple polyps as a sequel of chronic ulcerative colitis has been explained by numerous authors as resulting from undermined ulcers which produce a break in mucosal continuity, leaving an overhanging portion, which, being shut off by the regenerative process, forms a pedunculated, polyp-like tumor, with smooth or irregular marginal outlines. The elevations thus formed are surrounded by regenerating mucosa, and, as healing takes place, contraction no doubt leads to their further elevation. The same process isolates the polyps and not infrequently closes the glandular orifices, forming retention cysts. When the polyps become pedunculated the formation of the pedicle is, I believe, the result of the tug on the loose, underlying tissues by the peristaltic action of the bowel, thus producing a true polyp.

Hewitt and Howard, Struthers, and others, in considering the development of polyps resulting from inflammatory lesions, particularly ulcerative colitis, have stressed the importance of good blood supply, which causes the mucosa to be preserved and hastens the hyperplasia and regeneration of glands around the ulcerative processes. I have not been impressed in my cases with the fact that the polyps are found nearest the principal blood supply of the bowel. In all three cases which followed ulcerative colitis, I have demonstrated formation of polyps so diffuse, as to cover the entire intraluminary mucosa of the bowel. The idea of Ewing, Erdmann, and others, that these polyps may be followed through the transitional steps, from thickening and hyperplasia to adeno-carcinoma, is likewise, I believe, a possibility, the actual proof of which is more difficult to procure than in the congenital variety.

The following three cases of multiple polyps, scattered diffusely throughout the large bowel, secondary to chronic ulcerative colitis, are illustrative.

CASE IV.—A man, aged twenty years, was admitted to the clinic September 26, 1925. He had had dysentery and passage of blood for nineteen months, had passed a maximal of thirty to forty stools in twenty-four hours, and stated that his condition had been as bad as this for at least 100 days in succession. A diagnosis of amebic dysentery had been made elsewhere, although ameba had not been found.

The patient was found to be acutely ill. His maximal temperature was 102° F. He was passing many stools containing pus and blood, and suffered with rectal incontinence. He had lost twenty-four pounds. The abdomen was moderately tender. Proctoscopic examination disclosed involvement of the rectal and sigmoidal mucosa, associated œdema and of tendency to hæmorrhage, and scattered, punched-out ulcers.



FIG. 8.—Diffuse ulcerative colitis of entire colon with pseudo-polyposis.

A diagnosis of chronic ulcerative colitis was made. (Fig. 8.) In the next five months the patient's condition fluctuated. Improvement was slow, but by October 24, 1925, he had progressed sufficiently to be dismissed from observation.

The patient returned to the clinic in February, 1926, much sicker than before, reporting steady failure during the month. Proctoscopic examination disclosed large, sloughing, ragged, undermining ulcers of the rectum, with bridging of the mucosa between them. The condition was very serious, and ileostomy, as an emergency operation, was suggested. Because of the patient's extremely bad condition, however, it was not done. Treatment then consisted of administration of tincture of iodine by mouth, large doses of kaolin, bismuth, opium, camphorated tincture of opium, and small doses of vaccine prepared from the diplostreptococcus which was isolated in practically pure culture from the ulcers in the rectum. The patient improved slowly, and after several

months was able to go home. He came to the clinic again, September 22, 1926. He stated that he had gained thirty-seven pounds in the four preceding months and that he was having six to seven movements of the bowels in twenty-four hours, which only occasionally contained a little blood and mucus. The rectal mucosa contained a few pitted scars and slightly pale. There were many polyps, from 0.3 to 0.7 millimetres in diameter, and from 0.3 to 1.5 centimetres in length; some of them bled easily. The diagnosis was made of polypoidosis following healing in an extremely advanced case of chronic ulcerative colitis. Clinically, the patient was in excellent condition. He was dismissed with instructions to take vaccine subcutaneously. He returned May 23, 1927, clinically well, stating that he had had the best winter since the beginning of his illness. He had gained fifty pounds and looked the picture of health. He had had an average of three bowel movements daily for months and had not seen blood in the stools for at least a month. At this time proctoscopic examination disclosed the signs of healing after chronic ulcerative colitis, polypoid areas, and polyps. The small polyps, seen January 23, 1927, had disappeared. The mucosa between polyps was normal except



Fig. 9.                                    Fig. 10.

Fig. 9.—Acute colitis with ulceration and desquamation on a basis of chronic ulcerative colitis.
Fig. 10.—Chronic ulcerative colitis; partial destruction of mucosa with some evidence of healing.

for the scars of the infection. A series of fulgurations of rectal polyps was carried out without incident. The patient was then free of symptoms of all intestinal trouble, but because it had not been possible to fulgurate all the polyps at this first visit, he returned in December, 1927 at which time proctoscopic examination revealed that there were still several polyps in the rectum, but that the mucosa was in good condition. The polyps were again fulgurated.

August 9, 1928, the patient returned for observation and scars were noted in the rectum, but there was no ulceration. The lumen was practically normal in diameter. There were no polyps in the areas that had been fulgurated. A month later he returned with rapidly growing nodular lesions on the right arm. Surgical excision revealed hemangio-endothelioma. Treatment with radium and Röntgen-rays followed. There was no evidence of recurrence. During the severe exacerbation of colitis in 1926 the patient had suffered months of disability from what was designated peripheral neuritis. He had, at that time, constant burning pain in the balls of the feet, and later higher in the legs, so that he could not allow bed clothes to touch his feet. Anæsthesia and muscular weakness were present. Recovery from the colitis was accompanied by recovery from the neuritis.

Fig. 11.—Chronic ulcerative colitis involving entire colon; narrowing of lumen and obliteration of normal haustrations.
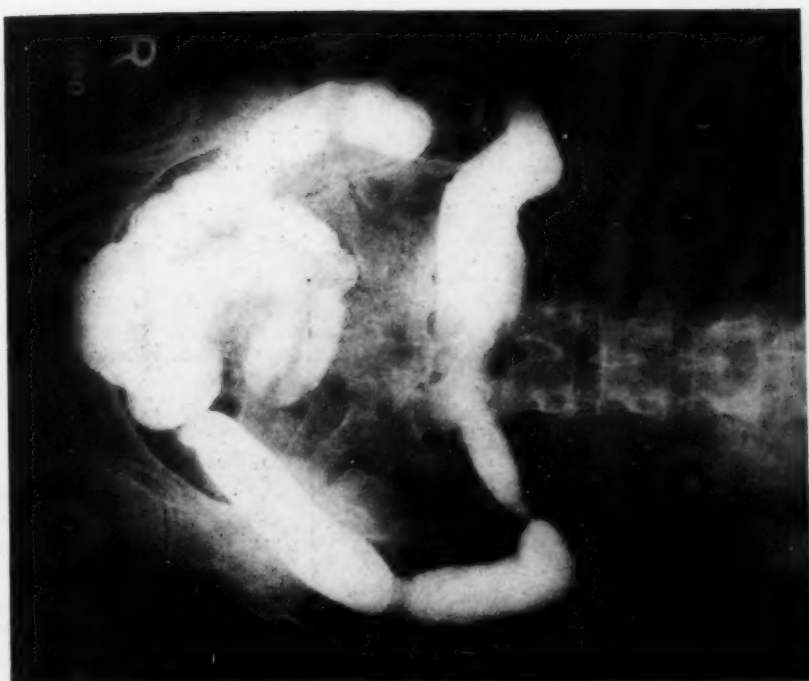


Fig. 12.—Chronic ulcerative colitis.

From May, 1927, until January, 1929, the patient was free of intestinal symptoms. About January 1, 1929, he had severe influenza, and after three weeks of this illness an exacerbation of the colitis occurred. Treatment was again instituted and gradual improvement resulted. In June, 1929, polyps were again seen through the proctoscope, some of which were large and firm. Operation was decided on because of the exacerbation of the colitis and the potential danger of malignant change in the polyps. October 15, 1929, ileostomy was performed. April 15, 1930, partial colectomy to a point near the rectosigmoid juncture was performed and October 14, 1930, combined abdominoperineal removal of the rectal stump was carried out. The patient had gained forty pounds since colectomy.

The pathologist reported diffuse inflammatory polypoid hyperplasia of the mucosa of the colon associated with acute colitis accompanied by ulceration and desquamation on a basis of chronic ulcerative colitis. (Figs. 9 and 10.)

Recovery was uneventful and the patient is now attending college.

CASE V.—A woman, aged twenty-three years, was admitted to the clinic first in December, 1918, with a history of watery diarrhœa, occasionally accompanied by passage of blood for two and a half years. At first there were only three or four daily rectal discharges, but the condition became progressively worse, so that on admission the number of movements had increased to eight or ten a day, and there was some abdominal cramping. During this period the patient lost twenty-nine pounds. A diagnosis of chronic ulcerative colitis was made by proctoscope and röntgenogram. (Fig. 11.)

The patient failed to improve under a medical care which was tried three months, so ileosigmoidostomy was performed February
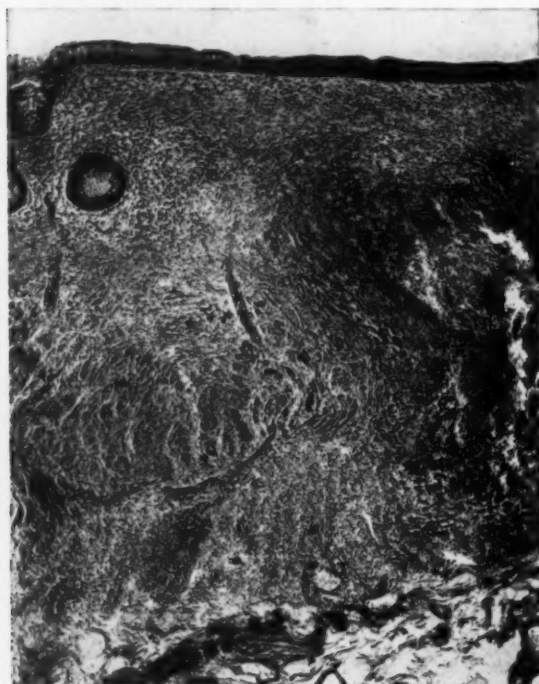


FIG. 13.—Chronic ulcerative colitis with evidences of healing.

19, 1919. At the same time, the divided distal end of the ileum, and the proximal end of the sigmoid, were brought out through the abdominal wound in order that the colon, thus excluded, could be irrigated. Although there was some abatement of sypmtoms during the next year, the patient was still disabled. Subtotal colectomy was therefore performed. (Figs. 12 and 13.) Improvement following the procedure was transient, due to the development of severe proctitis, with formation of stricture at the site of the anastomosis, accompanied by diarrhœa and considerable abdominal pain. All medical measures, including numerous injections of polyvalent dysentery serum, failed to cause benefit. Ileostomy was therefore performed January 21, 1925, and May 29, 1929, the rectal stump and remaining portion of sigmoid were removed by combined abdominoperineal operation. The patient made a satisfactory recovery from the operation, and, in spite of subsequent pulmonary hæmorrhages, associated with active tuberculosis, she maintains her normal weight and now leads an active life.

CASE VI.—A woman, aged twenty-seven years, came to the clinic first in June, 1924, with a history of bloody dysentery of one year's duration. The trouble began

with an acute cold and became progressively worse, so that in the three weeks prior to admission she had had an average of one rectal discharge of bloody, purulent material every fifteen minutes, day and night. (Fig. 14.) Ileostomy was performed August 6, 1924, after the patient had failed to respond to the usual medical measures of irrigation of the colon and administration of sedatives. Improvement followed the operation, but, in the succeeding years, severe, recurrent exacerbations occurred. In March, 1925, in the course of an acute exacerbation, an attack of erythema nodosum occurred. With another exacerbation in January, 1926, she began to suffer from generalized acute arthritis. From then until early in 1930, with each exacerbation of colitis, there was an acute



FIG. 14.—Chronic ulcerative colitis involving entire colon; marked narrowing of lumen with obliteration of normal haustrations.

exacerbation of arthritis. Periarthritic changes increased so that in the last two years she has been totally unable to perform any of her duties.

In 1926, treatment with specific vaccine was begun and the colitis gradually subsided. Non-specific foreign-protein therapy was given for the arthritis, and gradually the acute condition in the joints subsided, but the deformity of the hands, feet, knees and hips made motion almost impossible. In 1929, there was little if any intestinal difficulty, except that the rectum had narrowed so that it was a tube about 1 centimetre in diameter, and retained discharge caused much pain, discomfort, and general upsets.

Because of progressive disability from the arthritis, in spite of the general improvement of the patient, I felt that perhaps radical extirpation of a possible focus would bring good results, and total colectomy was performed.

August 6, 1924, ileostomy was performed; March 5, 1930, partial colectomy, and

October 24, 1930, combined abdominoperineal removal of the rectal stump were performed.

The pathologic report was hæmorrhagic ulcerative colitis with marked narrowing of the lumen and thickened walls. (Figs. 15 and 16.)

The patient has made a satisfactory recovery and has returned to her occupation as stenographer.

## TECHNIC

In extirpation of the entire colon, two procedures are available: (1) Operation in three stages, consisting of ileostomy, colectomy including the colon down to the rectosigmoid juncture, and combined abdominoperineal resection of the rectum; and (2) ileosigmoidostomy followed by colectomy. The latter method frequently leaves a rectum and sigmoid covered with polyps which must be treated by fulguration or other local destructive measures. It has the great advantage, however, of retaining the splendid sphincteric apparatus provided by nature and avoiding the necessity of making an abdominal anus. On the other hand, one is more likely to be compelled to remove the rectum at a subsequent stage after ileostomy and colectomy because of the presence of large and multiple polyps in it, rendering fulguration of uncertain value. Between the two operations one may vacillate, remembering, however, that after ileostomy and colectomy, if it is possible to get rid of the rectal polyps, a feasible step is to implant the ileum into the top of the rectum at a subsequent manœuvre.

In the six cases outlined, total colectomy was done in three stages. Ileostomy was the primary manœuvre and colectomy including the colon down to the rectosigmoid the secondary manœuvre; the third stage consisted of combined abdominoperineal resection of the rectum.



FIG. 15.—Hæmorrhagic, ulcerative colitis; marked narrowing of lumen; thickened walls.

Obviously, one should not attempt ileostomy and resection of the colon in a single stage. Ileostomy of itself is a serious procedure because of the disturbance of water balance which follows it. Most of the fluids are absorbed in the right portion of the colon, and to divert the fæcal current by ileostomy is to cause such rapid loss of fluid that the patient invariably loses weight and is dehydrated until such time as reëstablishment of the physiologic equilibrium takes place. At that time, the ileum begins to assume the function of the right portion of the colon, and the stools become semi-solid or formed.

The most satisfactory type of ileostomy is the single-barreled one (Fig. 17) in preference to the old-fashioned, double-barreled, or loop ileostomy.
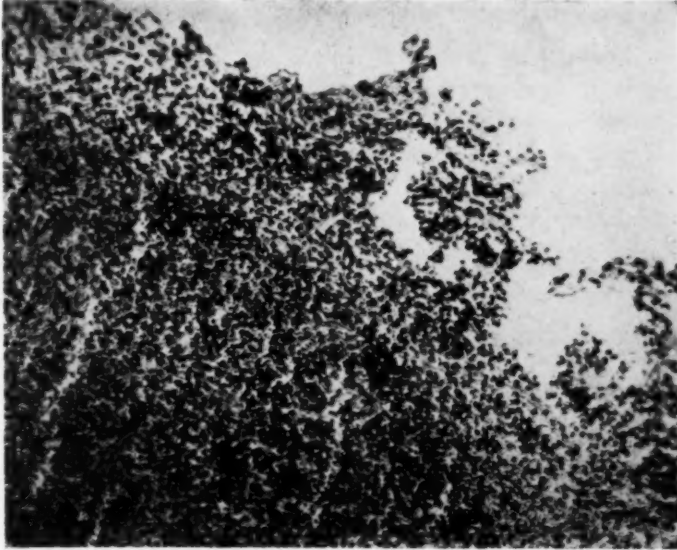


FIG. 16.—Chronic ulcerative colitis; marked inflammation of submucosa with practically complete destruction of mucosa.

I have divided the ileum close to the ileocecal valve, turned in the cecal end, brought the proximal end through a McBurney incision, leaving a clamp on
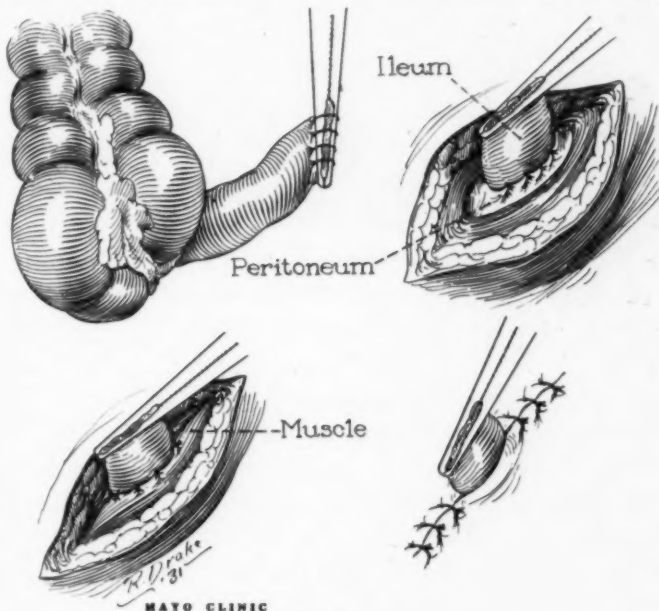


FIG. 17.—Technic of ileostomy.

it, sutured it very closely to the peritoneum, closing the wound snugly around it, and leaving the bowel obstructed for about forty-eight hours. As

one of the steps, I have shut off the space between the mesentery of the terminal portion of the ileum and the lateral parietal peritoneum, just as one would do in performing colostomy involving the sigmoid. This prevents obstruction by loops of small bowel slipping around the structures formed at ileostomy and becoming adherent. Since the ileostomy is made through a small McBurney incision, without exploration, and the wound heals tight, a single-barreled stoma results, which is not difficult to care for (Fig. 18).

I have found it advantageous to postpone the second stage of the resection for about three months. During this time the patient accommodates himself to the presence of the stoma, gains in weight, the stool becomes semi-solid or formed, and the general condition is much more favorable for a



FIG. 18.—After completion of ileostomy.

formidable resection than formerly. At the second stage the colon is removed through a long left rectus incision. The dissection begins in the right side of the colon, at the cæcum (Fig. 19), and the mobilization is made by dividing the outer leaf of peritoneum, just as one does in resection for carcinoma. The operation may be performed in a much less radical way than for carcinoma, dividing the vessels of the mesentery close to the wall of the bowel, and leaving adequate peritoneum to cover over raw spaces. After the right portion of the colon has been mobilized, guarding against injury to the ureter and retroperitoneal portion of the duodenum, and the vessels are secured and peritonization completed, the dissection is carried along the under-surface of the omentum. (Fig. 20.) That structure is left, but the transverse colon is readily mobilized around to the splenic flexure.
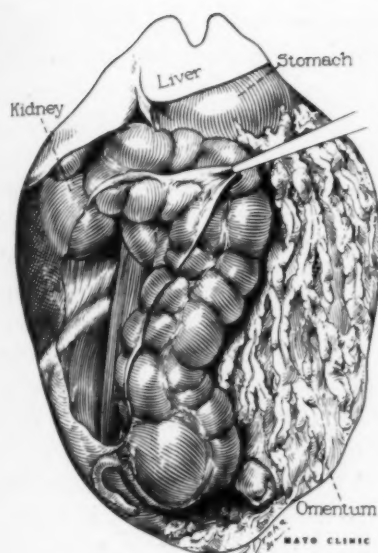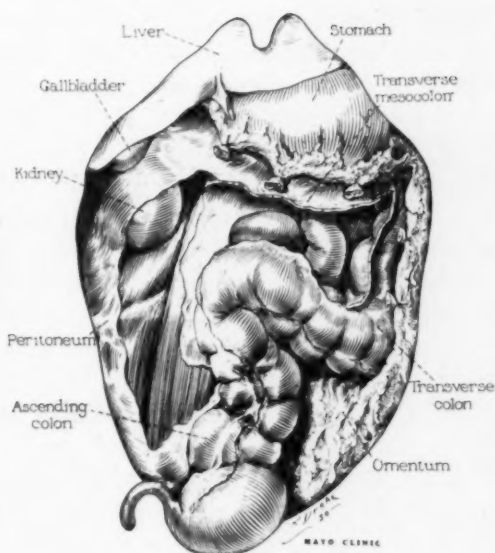
FIG. 19.



FIG. 20.

FIG. 19.—Beginning mobilization of cæcum and right half of colon. Incision is made through the parietal peritoneal attachment of the bowel and the dissection is made from without inward.
FIG. 20.—Further mobilization of the right portion of the colon and of the transverse colon. The omentum has been divided.



FIG. 21.



FIG. 22.

FIG. 21.—Mobilization of the colon has been carried down to the juncture of the descending colon with the sigmoid.
FIG. 22.—Completion of partial colectomy down to the middle of the sigmoid, the distal end of which has been inverted. The raw surfaces left by the dissection are closed with a running suture. The abdomen is then closed.

695

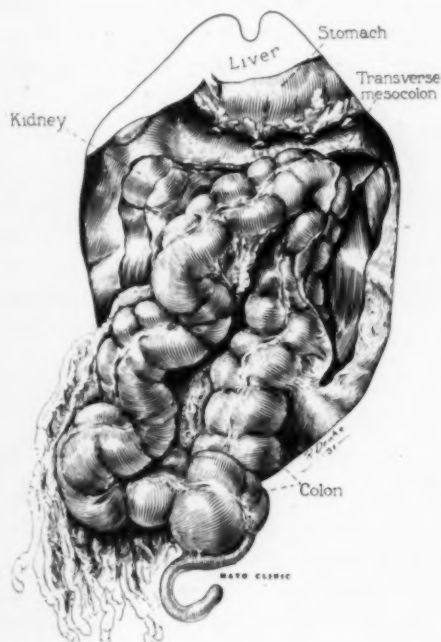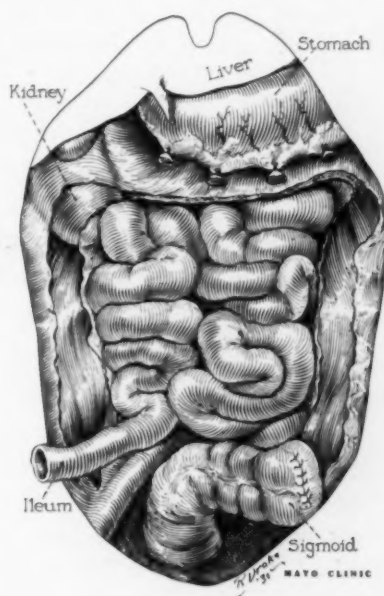Mobilization of the splenic flexure is the most difficult step in this manœuvre. It is higher than usual and is more likely to be fixed, but by dividing the splenocolic ligament one can readily clamp off its vessels and proceed downward with the mobilization of the descending colon and sigmoid. (Fig. 21.) The left parietal peritoneal leaflet is divided similarly to the right, these two segments of the bowel are loosened, the blood-vessels clamped out and tied, and the raw surfaces peritonized. I think it is wiser to divide the bowel at about the middle of the sigmoid or at the juncture of the lower and middle thirds of the sigmoid, so as to be sure of adequate vascularization of the end that is to be left in. (Fig. 22.) When colectomy is to be done for polypoidosis, it is a simple matter to select a point with good blood supply, dividing the bowel between clamps, with cautery, and turning in the lower end, with satisfactory knowledge that there will be small chance of leakage, formation of abscess or other complications. In ulcerative colitis, however, it is impossible to turn in the lower end with a suture, as anyone who has attempted it will readily recognize.

In the first case in which I performed total colectomy for polyposis secondary to ulcerative colitis, when the operation was completed down to the point of division of the bowel, a clamp was put across the bowel and closed, with the result that it cut through the entire intestinal wall, leaving a wide-open colon staring out of the peritoneal cavity. With this experience in mind, it has been my custom to divide the bowel, holding the lower end very lightly, and then suturing over and over, without attempting to turn it out; finally, wrapping it in iodoform gauze and bringing it out through the lower end of the wound. Drainage is instituted, and, fortunately, in these cases of colitis immunization is so satisfactory and complete that chances of peritonitis subsequently are less than in the congenital type of polyposis, in which patients have not had the opportunity of manufacturing their own antibodies.



Fig. 23.—Posterior incision for removal of segment of bowel left after partial colectomy.

The third stage of the operation is undertaken subsequently, after adequate rehabilitation which may extend over varying lengths of time for different patients. Certainly, I would not undertake it before two to three months had elapsed in any case, and if the patient were badly debilitated it could be put off longer. This stage of the operation is, in complicated cases, the most difficult of the three steps. Particularly is this true in cases of ulcerative colitis in which formation of abscess or fistulas has been one of the reasons for undertaking the total colectomy. I have been accustomed to doing this third stage after the method of combined abdominoperineal resection of the rectum, starting from behind (Fig. 23), mobilizing the rec-

tum up to the peritoneal fold (Fig. 24), but without opening the peritoneal cavity. This is accomplished in the same manner as the ordinary step of posterior resection for malignant growths, and when the rectum is entirely freed from its attachments up to the peritoneum, it is encased in a glove (Fig. 25), pushed back into the hollow of the sacrum, and the wound is closed. The patient is then turned on the back, an incision is made low in the median line, the inferior mesenteric vessels are ligated (Figs. 26 and 27), the pelvic peritoneum is cut through, and the entire lower segment of sigmoid and rectum is removed through the abdomen *en masse*. (Fig. 28.) This completes the operation, except for the making of a new pelvic floor
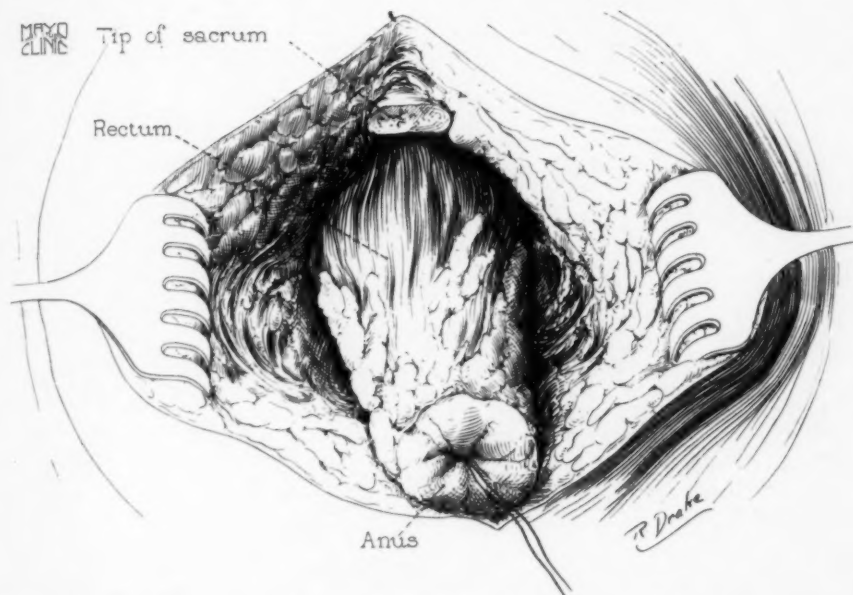


FIG. 24.—Mobilization of the rectum. The tip of the sacrum has been amputated.

out of peritoneum and instituting drainage posteriorly. Peritonization (Fig. 29), in my experience, has never been a difficult step, even in operating on men. It is possible to mobilize the lateral parietal peritoneum and to utilize the peritoneum from the bladder to such an extent that the floor is readily completed without much tension. In operating on women it is a very simple matter to complete the peritoneal floor by the use of the broad ligaments in addition to the lateral parietal peritoneum.

Drainage is instituted after the abdomen is closed. About half of the silkworm sutures which have closed the posterior wound are removed, and a gauze tampon and rubber-tube drain are inserted. This takes care of slow oozing which may be present in the large, wide-open pelvis, and also siphons off the serum which necessarily will collect. The tampon is removed about the seventh or eighth day, after having been loosened by irrigations and by the use of peroxide of hydrogen. It is astonishing how

quickly some of these large cavities will close and contract down to a small drainage tract which, after several weeks, entirely disappears. One patient who underwent combined abdominoperineal resection of the rectum I dismissed on the nineteenth day, with a draining sinus which was comparatively small, but the usual patient ordinarily takes about four weeks in the hospital after this stage of the operation.

Rehabilitation after these formidable procedures is slow, and adequate dietary measures and other steps for increasing the patient's resistance are
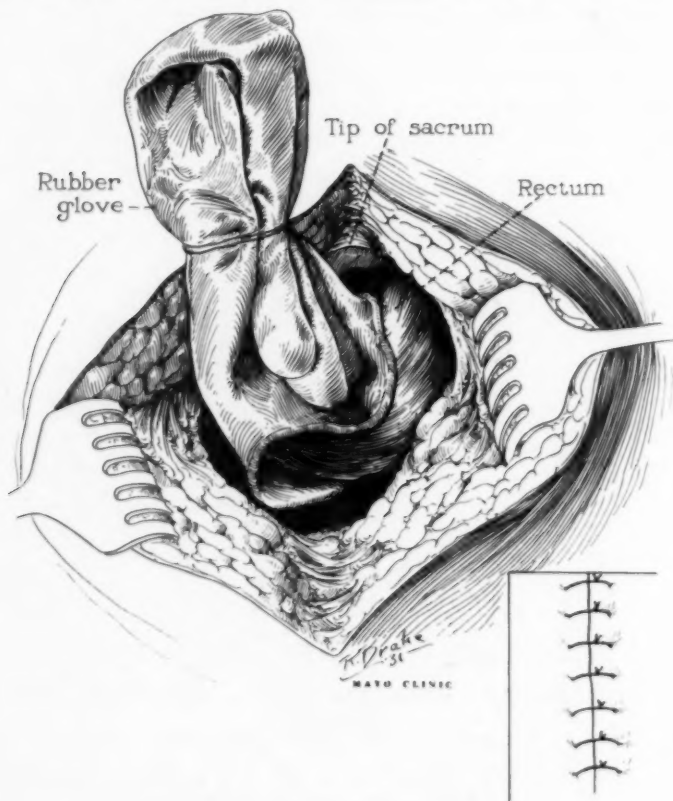


FIG. 25.—Completely mobilized rectum encased in rubber glove. Insert shows wound closed after segment is dropped back into hollow of sacrum.

urgently indicated. The immediate post-operative care of these patients, following the third step, is similar to that following any combined abdominoperineal resection.

In this series of six cases there has not been a death from operation.

I particularly want to call attention to the advantages of graded removal of the large bowel and rectum when its extirpation is necessary, and to emphasize the thought that polypoidosis, and particularly the congenital variety, is a potentially malignant condition which warrants radical measures before metamorphosis into carcinoma has taken place. As for the other indication for resection, complicated chronic ulcerative colitis, it is evident that the

question of focal infection must be a very urgent one before such radical surgical measures can be undertaken, but here, too, polypoidosis or pseudo-
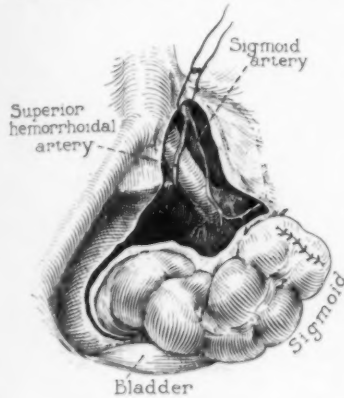


FIG. 26.

FIG. 27.

FIG. 26.—Anterior approach following posterior mobilization of rectum. Ligation of blood-vessels to sigmoid and rectum.
FIG. 27.—Division of peritoneum for mobilization of sigmoid and exposure of left ureter.
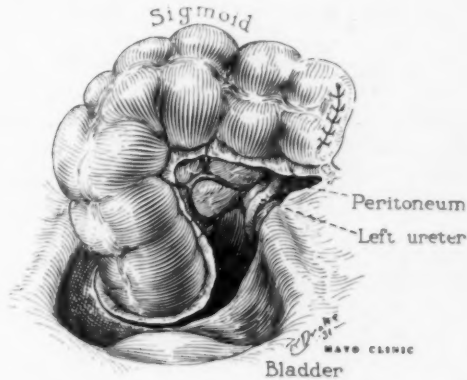
polypoidosis, whichever one chooses to regard it, unquestionably is a fore-runner of malignancy in certain cases.
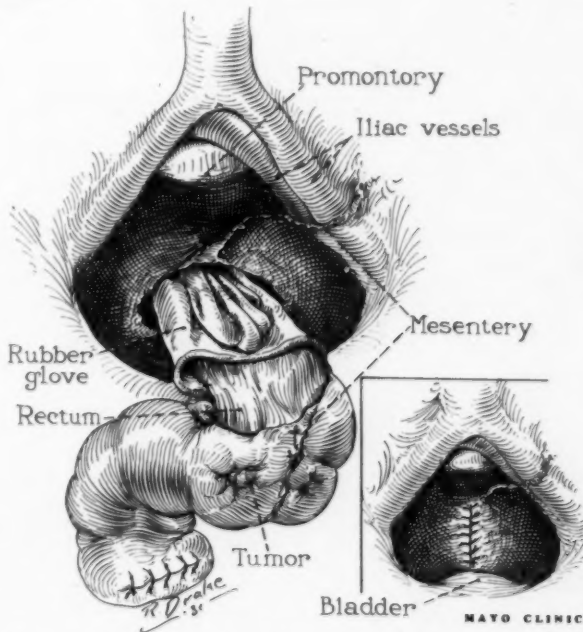


FIG. 28.—Entire rectum being lifted out of hollow of sacrum. Peritonization of pelvis completed.

DISCUSSION.—DR. FRED B. LUND (Boston) showed a lantern slide in illustration of Doctor Rankin's paper presenting the effect on the large intestine of a very long constituted ulcerated colitis.

The patient was a little woman upon whom an ileostomy was done nine years ago.

She had ulcers, and Doctor Lund hoped, as had been in other cases, that putting the colon at rest would cure this ulcerated colitis; but the ulcers never healed. Although she had bloody stools and mucus for nine years, she kept very well and did all her housework. One day she turned up with a very large abdominal tumor in the upper left quadrant. She had grown very thin; her red blood count was down to just a little above two million. He supposed that she had developed a carcinoma. He did an exploration and found that there was a tremendously inflamed colon and the tumor was the inflamed, swollen, thickened omentum. With a transfusion before and after the operation it was easy to remove that colon. She recovered and has since done very well.

As to Doctor Eggers' observations on diverticulitis, the speaker was of the opinion that whenever one finds a left-sided appendicitis in a fat man of about forty, which feels like a tumor, one can be sure it is a diverticulitis. In rare cases of appendicitis where the tenderness is on the left, the appendix goes down to the bottom of the pelvis; or the tenderness on the left may be due to inflammation or obstruction making the external coils of the ileum distend. But one can generally tell these diverticulitis cases. He recalled the case of a woman who had an abscess about the size of a pigeon's egg between the layers of the mesentery of the sigmoid. That was drained. The abscess worked down into the pelvis, where it was drained through the rectum. But it never seemed to be drained sufficiently, and after eight months of watching that woman fade away she died.

Another case shows what can be done in severe cases of diverticulitis by multiple operations. This was a very fat old woman of sixty-five, with an acute intestinal obstruction, which was much distended, in which immediate operation had to be done. A left-sided incision was made and an enormous sigmoid was brought out. The intestine was opened above it. The next day fæces poured out, and here was this great mass on the outside of the abdomen. But it did not



Transverse mesocolon — Liver — Stomach — Ileum

MAYO CLINIC
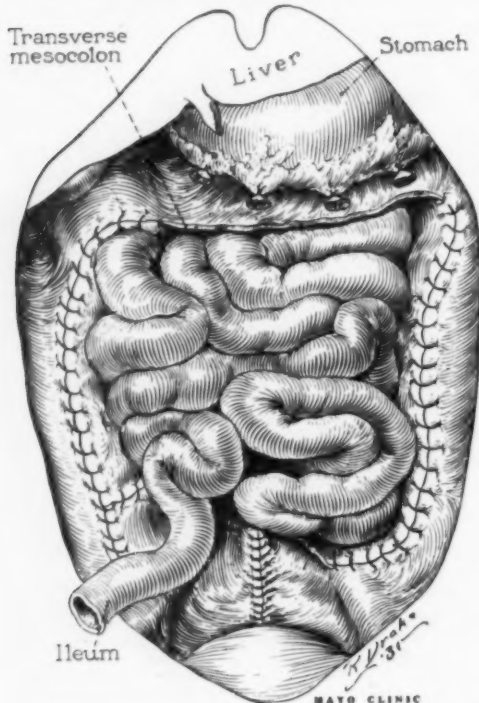
FIG. 29.—Total colectomy completed. The raw surfaces left by dissection are closed with a running suture. A new pelvic floor has been made out of peritoneum.

feel like a carcinoma; it was pretty smooth. A week or ten days later that was cut off according to the Mikulicz procedure and an enormous amount of pus came out from between the layers of the mesocolon and also around it. If one hadn't waited until that was walled off one would have lost the patient. Her heart went on all right, although she had an intermittent pulse, and the clamp was put on. Subsequently, without ever opening the peritoneum again that whole thing quieted down and it was possible to suture the bowel. It held, and she went home in excellent condition, with her heart better than it had even been for years.

Suppuration between the layers of the mesosigmoid is one of the worst things which may happen in these cases of diverticulitis, and it has been his experience that when the abscess has been opened, they subsequently come to a resection. In cases where there is a multiple diverticulitis, but only one section is inflamed, one can disregard all the area that is not inflamed and resect the inflamed area as if it were a carcinoma, and they get well.

# TOTAL COLECTOMY

Dr. Daniel F. Jones (Boston) said that in regard to diverticulitis, he did not think many require operation. Most of these cases would get on better with an oil or diet régime, such as Doctor Eggers gave, rather than with a resection. A resection in these cases is a very serious operation, too serious for the condition, because a great majority of the cases go on. He had seen an abscess opened and the sinus drained for a long time, it is true. But in quite a percentage of the cases they close.

Doctor Rankin in his paper has brought out, and spoken of, an operation which ought to be done much more often, and that is an excision of the colon for polyposis. These cases go on, he was perfectly sure, and die of carcinoma unless this is done. It is, therefore, reasonable that these cases should have the colon removed when they are found.

In a recent case, in a girl of twenty-three, who was operated upon for carcinoma of the rectum, when they took out the rectum they found carcinoma of the sigmoid. They took that out and found three other carcinomas along the colon. In other cases it is the same. There are many of them. He was sure that the colon should be removed in these cases.

As to chronic ulcers and colitis—he was not sure about the carcinoma form of these ulcers, but he was quite sure that the colon should be taken out in a few of these cases of chronic ulcerated colitis. It can be done without a great mortality. Of course, the real mortality comes before the operation, from intestinal obstruction.

He judged from the X-rays presented by Doctor Rankin that he has taken out the whole omentum. It is quite easy to leave the whole omentum. The omentum is attached to the transverse colon by a very thin peritoneum and very few vessels. By freeing the omentum from the transverse colon and turning it up, it can be left very easily and makes a very good cover for the small intestines, and does help to prevent obstruction.

Dr. J. Shelton Horsley (Richmond, Va.) remarked that one of the chief dangers in resection of the colon is sepsis. This may be avoided partly by the technic employed, but there are other measures in the preparation of the patient that are even more important than the technic. A preliminary preparation of the patient, as Doctor Rankin has so often emphasized—by giving a diet composed largely of carbohydrates and fruit juices and by injections into the peritoneal cavity either of a vaccine or dextrose—is even more important than the method of operating.

Another highly valuable measure is reduction of the quantity and virulence of the intestinal bacteria by giving the bowel rest. When the lesion is in the transverse or left colon this can be done by a muscle-splitting incision on the right side, bringing up the cæcum and ascending colon well into the wound, dividing the external layer of the mesentery to this bowel if necessary, and placing a glass rod under the bowel. If there is marked obstruction, a rubber tube can be introduced at once, and after two or three days a longitudinal incision is made in the bowel on the oral side of the glass rod. This is the old method of doing an enterostomy, especially as practised on the sigmoid for cancer of the rectum, and is a useful procedure. By this means the colon is given complete rest—not merely the partial rest that would occur from the introduction of a catheter with the bowel in the peritoneal cavity. After ten days the resection can be done with comparative impunity.

Another cause of trouble is the poor blood supply in the large bowel. This is a well-known anatomic fact and frequently causes leakage along the suture line. Often after the mesentery to the affected loop of bowel has been divided and tied it is assumed that the circulation at the proposed site of resection is normal. If, however, the mesentery is cut at its junction with the bowel it is often found that here is no circulation, or it is very feeble, at this point. It seems a good plan to continue this division of the mesentery at its junction with the bowel until a spurting point is encountered in the mesentery. Here the resection can be made with an assurance of circulatory competence.

Doctor Horsley uses the basting-stitch technic of Doctor Kerr. It is ingenious and attractive, and in many cases it has worked out well. In two of his patients, however, it was not satisfactory and mortality resulted. The objections to this basting-stitch technic are these: (1) In placing the basting stitch it is sometimes difficult not to penetrate the bowel. If the bowel is penetrated the stitch is infected, and when it is pulled out it spreads the infection along the track of the stitch and in the peritoneum. Even when carefully inserted there is sometimes eversion of the mucosa. (2) Occasionally the stitch hangs and it is difficult to remove. This traction on the basting stitch may disarrange the permanent sutures. In one case he found it necessary to open the bowel in order to remove the basting suture, and the patient died. (3) A large amount of diaphragm is turned in, so obstructing the lumen. This consists not only in the amount of tissue already turned in by the basting stitch, but in the tissue between the basting stitch and the permanent suture, even assuming that only one row of permanent sutures is used. Unless the calibre of the bowel is large, this diaphragm may produce complete obstruction, and while such obstruction may be overcome in experimental animals such as dogs with strong intestinal muscles it is of serious consequence in man, as he knows from personal experience of a fatal case. (4) The mucosa in the basting-stitch technic is not accurately approximated. While this is of no particular consequence in a small bowel whose contour is smooth when there is a small amount of diaphragm, in the large bowel where the contour is irregular and when a deep diaphragm is turned in by the basting stitch the fecal matter may lodge in between the mucosa of the two ends of the bowel and cause trouble. A narrow, firm line of apposition of the whole bowel wall (as often observed after the Murphy button) gives the most desirable eventual results.

If the colon is drained for at least ten days before the resection by a complete enterostomy opening, the resection can be done with almost as much safety in the colon as in the upper small intestine under ordinary conditions. The mucosa and the whole bowel wall are sutured with linen or silk from *within* as far as possible, this including the mesenteric portion, and then the remaining portion can be whipped over from without if necessary, tying the suture to the original end. Over this is placed a series of interrupted mattress sutures of catgut, and after tying them the ends should be passed through some adjacent peritoneal covered fat, such as the omentum. The enterostomy should not be closed for at least ten days after the resection.

Dr. W. E. Sistrunk (Dallas, Tex.) said that he had always felt, in the work he had done, that the high mortality which came from operations on the colon came, in many instances, from the effort to accomplish in one operation something which really should be divided into several different stages. A great many patients have been lost through failure to appreciate that a patient can stand so much and no more; and that if one does try to divide operations into stages, although a good deal of time is lost to the patient, that many times the patient may be sent home well instead of the wrong way.

He had always felt in resecting the ascending colon that he obtained better results by carefully preparing his patients beforehand, in order to get the bowel as empty as possible, then through a left incision by making an ileocolostomy. This ileocolostomy allows drainage below the loop which may be partly obstructed and puts it, to a great extent, at rest. This does away, to a great extent, with the acute infection which surrounds practically all carcinomas of the bowel.

After a period of two or three weeks has passed, and the patient is up and about, one can go back to a perfectly clean incision on the right side and resect the bowel, after it has been mobilized, and then have nothing to do but close off the two ends of the bowel, the ilium end and the end of the transverse colon, and the operation is completed. Many times this can be done without any draining, and only a delay of two or three weeks is occasioned by this step.

In dealing with acute sigmoiditis and with diverticulitis, one must be extremely careful. A great many of these patients who have had slight attacks, indicating trouble from a diverticulum, will get along very nicely indeed through care, as far as their diet is concerned, and through the use of mineral oil and other measures to obtain bowel movements and to prevent constipation. In acute cases it would be extremely dangerous to attempt anything in the way of a surgical procedure until the patient has developed an immunity to this infection which has become acute. After a period of seven to ten days, or possibly twelve days if it becomes necessary, one could drain the abscess and then leave the case alone and see whether or not something would be necessary later on. If one finds an obstruction present, he much prefers, in preference to attacking the local area, to make a colostomy of the transverse colon and suture the lips of the bowel together so it can be closed later. After a period of two, three, four, six, or seven months, one can go back and do whatever seems necessary to the sigmoid.

Doctor Rankin's technic, by doing the operation in two stages, is certainly the soundest way to do an operation of that sort. It is certainly a most formidable operation, but we see cases that have polyposis which extends throughout the bowel which have to be cared for in some way, otherwise malignant polypi develop and they lose their lives. On the other hand, there are certain cases of ulcerated glands, cases that have a great deal of trouble from the bowel that is left, which evidently have a streptococci infection which extends to the bowel. They are very miserable even after an enterostomy has been made. The operation has a field of usefulness.

Dr. LINCOLN DAVIS (Boston) recalled a case that had a resection of the right side of the colon, about five years ago, for carcinoma of the cæcum. At the point where the transverse colon was severed the bowel was found to be full of little polypi. A lateral anastomosis was done, and the man left the hospital. He has been under observation now for five years. With a proctoscope one can see multiple polypi scattered throughout the rectum, as far up as can be seen. One or two of these have been removed and examined and found to be benign. Although advised to have a resection of the remainder of the large intestine, the man demurred. He has been very comfortable. Occasionally he passes a little blood, but otherwise has no symptoms. Undoubtedly he will develop carcinoma eventually.

The point is that he has had five good years, without an artificial anus. If a total colectomy is done he would have to have an artificial anus. He would rather run the chances of developing a carcinoma than have a resection with an artificial anus.

Dr. F. N. G. STARR remarked that some years ago when he was making very accurate records and everything of all of the gall-bladder cases cultured, and in an analysis of 600 of these there was 6 per cent. that presented a culture of staphylococcus. All of these patients had suffered from diarrhœa, all of this 6 per cent. In some of them there was observed at the time of removing the gall-bladder that there was a certain amount of colitis. They all cleared up after they had the gall-bladder removed.

Following that experience a woman arrived who had been in England some ten months previously and upon whom Doctor Shenstone did a colostomy for a very pronounced ulcerative colitis. She came to me to see if it was time to have it closed. It wasn't; there was still a very active ulcerative process going on. Upon going over her he found a tenderness over the gall-bladder, and upon examination found it was a non-functioning, or slow-functioning, gall-bladder. He took it out, and the pus discharging from the colostomy opening ceased three weeks after the operation. The colostomy was closed three months later and she has been well ever since.

Possibly that may, in certain instances, be a cause of some of these cases.

He had been struck, too, sometimes in opening an abdomen years after a previous operation to find out the reconstructive powers of the intestinal tract. For instance, a woman upon whom he did a complete colectomy for ulcerative colitis some years ago returned at the end of six years complaining of great frequency in menstruation. Upon X-ray examination he found a definite kink at the point of the anastomosis of the ileum

to the sigmoid, which apparently was adherent to the top of the bladder. He reopened her. Although the entire sigmoid had been removed, he found little bunches of fat running up the ileum for about six or eight inches and one of these had become adherent to the bladder and produced the kink. The release of that immediately gave her complete relief.

DR. HARRY H. KERR (Washington, D. C.) differed from Doctor Horsley as to the disadvantages, or the weakness, of the basting stitch.

The question of turning in too much bowel depends upon three factors: How much has been crushed in the clamp; how far the basting stitch is taken from the clamp, and how far the anastomosing stitch is placed from the basting stitch.

In the large bowel the amount of invagination is not of as great importance as in the small bowel. In the small bowel, the higher you go the more the partial diaphragm interferes with the lumen of the bowel and the greater the danger of obstruction. In operating on children, or the small bowel of adults, we divide the bowel at an angle to its axis. If it is divided at an angle of 45 degrees, the circumference of the stoma is twice the circumference of the bowel and the danger from invagination disappears.

If one uses a single anastomosing suture one reduces the amount of the invagination. The question of the amount of invagination is easily controlled and should never cause obstruction. By the use of a single anastomosing suture the amount of invagination is materially reduced.

As to the difficulty from breaking the basting stitch in my earlier experience, I had a basting stitch break but I now use stout Pagenstecher linen. Stout waxed Pagenstetcher linen, I think, should be used.

As to the possible advantage of suturing the mucous membrane, he does not believe that holds because he does not believe you can suture the mucous membrane and get primary union. We all know that intestinal union is not by the healing of like tissues but by the agglutination of the peritoneum that subsequently becomes organized.

# THE CHOICE OF OPERATION IN CARCINOMA OF THE COLON

## By David Cheever, M.D.

### of Boston, Mass.

Even were it desirable, it certainly is not possible completely to standardize the treatment of any disease. Such a multiplicity of variable factors are involved, in the patient himself, in his disease, in therapeutic measures, and in the physician who applies them, that any attempt at actual standardization is fallacious and unlikely to prepare the physician to meet an unusual and unforeseen situation when it arises. Nevertheless a classification of the types of a disease and a knowledge based on experience of what measures have proved best to meet each typical condition are absolutely essential to prompt and efficient action. Of no disease are these statements more true than of carcinoma of the colon, and yet, in the selection of operative measures in this condition very great divergence of opinion exists among surgeons of experience as to what methods are best.

The chief variables which may modify the plan of treatment are first, the portion of the colon invaded by the lesion; and second, complications caused by the growth. Such others as the general condition of the patient, the presence of coincident disease, and the experience of the surgeon are common to all surgical problems and need no discussion here.

The exact location of the growth in the colon is of great importance in determining the symptomatology and course of the disease and the selection of operative methods. This is well understood by all surgeons and needs only a brief review here. The proximal colon from the ileo-cæcal valve to the splenic flexure, derived from the foregut, absorbs the greater part of the water from the ingesta, together with such part of the nutritious materials in solution as have not already been taken up by the small intestine. Its contents are swarming with bacteria, among which the *Bacillus coli communis* and certain saprophytes predominate but which may include also all sorts of pathogenic organisms. Its calibre is large and diminishes progressively towards its distal portion. Its blood supply and lymphatic circulation are less abundant than in the ileum, but are still comparatively rich in the cæcum and ascending colon, and diminish distally. Its contents are quite fluid in the cæcum and become more pultaceous and semi-solid as they pass onward. Peristalsis, and the absorption of toxic materials as well as of nutritious substances is active—it would seem also that the cells of a malignant neoplasm are likely to be taken up readily by the blood and lymphatic stream. The distal colon, on the other hand, is smaller in calibre until the sigmoid flexure is reached, its vascular supply and lymphatic circulation are relatively poor, peristalsis is less active, and its contents lose more and more of their fluid components and become progressively more solid. Bacteria,

45

probably on account of the lack of fluid media, are less numerous, and it seems probable that the absorption of cellular elements is less free, although on this point there is a difference of opinion.[1, 6] The transverse colon forms the connecting link between the more characteristic parts of the proximal and distal colon, and its peculiarities and function grade insensibly from one to the other, but from a surgical point of view it is convenient to regard it as a separate entity, so that for our purpose we may consider the colon to be divisible into three parts: The proximal, from the ileo-cæcal valve to a point beyond the hepatic flexure; the mid-colon, from the hepatic to the splenic flexures; and the distal which includes that portion from and including the splenic flexure to the beginning of the rectum opposite the third sacral vertebra.

On account of these conditions, as is well understood, a tumor of the proximal colon seldom causes obstruction, but is likely to grow rather rapidly, to interfere with peristalsis and thus cause pain, to ulcerate and bleed readily and thus cause anæmia, and to give off poisonous degeneration products which may be absorbed and cause toxæmia; whereas the same type of tumor in the distal colon is likely to be of slower growth, to cause obstructive symptoms, to bleed less readily and perhaps to metastasize later.[1, 6]

The variables which have to do with complications caused by neoplasm of the colon, irrespective of its location, are chiefly obstruction, extension of the growth to neighboring organs, metastases by the blood or lymph-streams, and perforation with local abscess or peritonitis. Partial, intermittent intestinal obstruction wears the patient down by its colicky attacks of pain, anorexia, alternate attacks of constipation and diarrhœa, and interference with the patient's nutrition, while complete obstruction introduces an emergency which must be dealt with at once, with the object of giving immediate relief and with the secondary but not less important object of radical removal of the cause when this is possible. Involvement of nearby organs by direct extension, or of tributary lymph-nodes and distant tissues by blood or lymphatic metastases, introduces self-evident operative problems. Perforation of the bowel wall by the lesion causes local abscess or local or general peritonitis which will require immediate and perhaps heroic measures for their arrest before the underlying problems can be attacked. Different combinations and degrees of these variables may present such a great variety of conditions that it is of the utmost importance that the surgeon should have a general plan of campaign in mind to meet them. It is with the hope of presenting more evidence on which to base such a plan that the experience of the Peter Bent Brigham Hospital is here presented.

Since the hospital admitted its first patient in January 1913, to June 1931, a period of seventeen and one-half years, 154 patients with carcinoma of the colon have been operated on. Of these eleven had a simple exploration, of whom seven recovered and four died, giving an operative mortality of 36.3 per cent.; fifty-eight had a palliative or short-circuiting operation for the relief of obstruction with thirty-six recoveries and twenty-two deaths

—a mortality of 37.9 per cent. and eighty-five had radical resections, among whom were seventy recoveries and fifteen deaths—a mortality of 17.6 per cent. It is with this group of eighty-five radical resections that this report is concerned.

A general principle so widely accepted that it needs no support is that of the expediency of a preliminary proximal drainage operation, especially if there is any degree of obstruction. This is borne out by the following figures.

Resection with preliminary cecostomy or colostomy..... 35
Recovered ........................................... 32
Died ................................................. 3
    Mortality ...................................... 8.5 per cent.

Resection without preliminary drainage................ 50
Recovered ........................................... 38
Died ................................................. 12
    Mortality ...................................... 24 per cent.

In other words, taking all cases of radical resection, the mortality was nearly three times higher among those without preliminary drainage.

Carcinoma of the right colon anywhere between the ileo-cæcal valve and a point beyond the hepatic flexure, is quite unanimously considered to be best treated by removal of the whole right colon and anastomosis between the terminal ileum and the transverse colon. This is because: (1) removal of a lesser part hardly gives a wide enough margin of safety; (2) the proximal colon being incompletely covered by peritoneum and having a good deal of attached fat or membranous veils is less amenable to anastomosis; (3) the ileum has a rich blood supply which minimizes the liability to suture line necrosis; and (4) the operation is relatively easy. Opinion does differ, however, as to how the anastomosis shall be made—whether end-to-side or side-to-side, in one or two stages, and whether it should be accompanied by a proximal safety-valve ileostomy of some type. Bell,[1] Judd,[2] Rankin,[3] and others advise an end-to-side ileo-transverse colostomy with simultaneous safety-valve ileostomy by a small rubber tube; Goetsch[4] advises a three-stage procedure comprising first a cecostomy, then an ileo-transverse colostomy with omental interposition and finally at the last stage, an excision of the right colon. The great majority of writers prefer a single-stage procedure and this has been the usual method in the present series. A total of twenty-one patients with carcinoma of the right colon was operated on, with sixteen recoveries and five deaths, giving a mortality of 23.8 per cent. The operation of choice was end-to-side anastomosis of the terminal ileum to the transverse colon, which was done eleven times with one death, a mortality of 9 per cent. The fatal case involved a multiple resection of the right colon, a part of the gall-bladder and duodenum, and was followed by death in nine hours from shock—a case in which obviously the method of suture was not at fault. A side-to-side anastomosis was done seven times with three deaths,

a mortality of 42.8 per cent. Two of the patients who died had extensive metastases, one of whom developed peritonitis and ileus, but apparently rather from handling the infected neoplastic bowel wall than from a leaking anastomosis, which could not be demonstrated. The third fatality occurred from cardiac failure in 24°. In addition to these preferred methods, there was one instance of successful resection of the hepatic flexure followed by side-to-side ascending-transverse colostomy with simultaneous cæcostomy, and one successful case of end-to-end anastomosis of ileum to transverse colon—made easy by the great distention of the former. The fifth fatality in this right-colon group was due to shock and peritonitis following an emergency Mikulicz procedure made between limbs of the ileum and transverse colon necessitated by the collapse of the patient on the operating table. In one of the successful end-to-side anastomoses in a patient with extensive hepatic metastases a simultaneous ileostomy was done. The average period of hospitalization of patients upon whom successful right colectomy was done was 22.3 days. The analysis of the records of this group does not suggest that any of the five fatalities could have been avoided by a provisional ileostomy. Four of the patients showed extensive metastases and one had chronic cardiac disease, and in the one instance where peritonitis was a factor no leak could be demonstrated at autopsy. The conclusion seems justified that the best method of handling carcinoma of the right colon is by resection of the entire right colon, with end-to-side anastomosis of ileum to transverse colon, without preliminary or simultaneous ileostomy. It is possible that in selected cases a fractional method in stages as suggested by Goetsch might be useful.

In the transverse colon we are dealing with a portion of the bowel which is mobile, entirely covered by peritoneum except for the omental attachment, possessed of a good but not rich blood supply, and containing semi-fluid or pultaceous fecal contents, which may become inspissated and lumpy in the presence of marked stasis. Obstruction is not common, partly because the fæcal stream is fluid enough to pass through a small opening, and partly because the superficial position of this portion of the bowel makes it likely that the tumor will be noticed by the patient or his physician before the symptoms are advanced. The bowel being mobile by virtue of its long mesentery, resection can be carried out without great difficulty—on the other hand, these tumors seem to be peculiarly liable to involve the greater curvature of the stomach and to a less extent adjacent coils of intestine. The problem here is to decide whether a primary resection shall be carried out, and if so, by suture anastomosis or by the Mikulicz procedure; and whether by either method there should be a simultaneous proximal safety-valve cæcostomy or colostomy, or a preliminary one made some days before the resection.

The advantages and disadvantages of some of these methods must be carefully considered. With most authorities a cæcostomy is the ideal form of temporary safety-valve. Among its advantages are that it is certain to be proximal to any colonic lesion even if the exact situation of the latter is not known; the location of the cæcum is very constant and the operation

usually easily done; and it is likely to close spontaneously if properly made. Among its disadvantages are the fact that it usually only diverts a small portion of the fæcal stream, and thus while relieving the strain of gaseous distention on the resection suture line, it nevertheless permits it to be constantly soiled, and does not do away with the occurrence of distal peristalsis which may interfere with healing; if it does happen to drain most of the intestinal contents, the patient's nutrition may be considerably interfered with; finally, although a cæcostomy is supposed to heal spontaneously, it does in fact sometimes require operative closure. A cæcostomy which completely diverts the intestinal contents would be most difficult to make on account of the fixation and size of the cæcum and would seem to be most unwise on account of the patient's nutrition, although Gordon-Taylor[5] is an advocate of it. A similar type of safety-valve in the proximal transverse colon would present many of the same advantages and disadvantages, although permitting more absorption of the intestinal contents, but a colostomy of permanent type at the same point, made by bringing a loop outside the abdomen, would completely divert the fæcal stream, and would permit cleansing of the field before, and complete rest after, the resection.

The question whether a resection may be most advantageously done by immediate suture or by the Mikulicz procedure method is one deserving careful study. The latter is widely advocated and practised, but authorities differ in appraisal of its merits, as is shown by the statement of Coffey:[6] "It is probable that there has never been so important a principle introduced into intestinal surgery as the Mikulicz principle," and that of Bell[1] to the effect that the operation of Mikulicz should be abandoned owing to length of hospitalization, high percentage of recurrence, danger of vascular thrombosis and post-operative herniation. It should be clearly understood what is meant by the Mikulicz operation. As originally proposed by von Mikulicz, it consisted of drawing out a loop of mobilized colon with the tumor at its apex, closing the abdominal wall about the afferent and efferent limbs, and after Nature had sealed off the peritoneal cavity, cutting away the loop including the tumor and its mesentery, and subsequently destroying the spur between the limbs by crushing forceps and encouraging the retraction of the bowel ends and spontaneous closure. It is obvious that this operation did not permit resection of the tumor by a wide margin, or complete removal of tributary glands, and as a result recurrences were common, and there were many instances of tumor implantation in the abdominal wall. As usually practised at present the method has been much modified. The colon is mobilized to the necessary degree, an adequate resection of bowel and mesentery is done, the two limbs are sutured together bringing peritoneal surfaces in apposition, and the ends are brought out of the abdominal wound; subsequently the spur or partition between the limbs is destroyed by pressure clamps, and the fæcal fistula allowed to close if it will or be repaired by secondary operation. Rankin[3, 7] states that the Mikulicz procedure is usually only a palliation, mentions the danger of infection and peritonitis and the

liability of the ends to retract as late as seventy-two hours, and states that in 183 cases at the Mayo Clinic the mortality was 9.6 per cent. to which must be added 7 per cent. of recurrences in the abdominal wall. He says that general statements as to its mortality and end-results are not confirmed by studying a group of cases. He finds useful application of the method in a few selected cases. Gehrels[8] states that the Mikulicz procedure seems to have the lowest mortality and advocates a modification which avoids the "un-surgical" crushing of the spur which may lead to pain, hæmorrhage, stenosis and peritonitis, and substitutes a painstaking freeing of the double-barrel colostomy several weeks after the resection, with end-to-end suture, not hesi-tating to enter the peritoneal cavity. Gordon-Taylor[5] asserts that the Mikulicz type of procedure has the lowest mortality but advises a preliminary cæcostomy of a type to divert entirely the fæcal current, which would seem to imply that one of the chief advantages claimed for the Mikulicz method—free drainage of the bowel from the proximal opening of the double-barrel, is in fact, negligible. Sistrunk,[9] considers the operation as the safest method in certain cases of carcinoma in the mobile portion of the colon, but the contraindications which he gives limit its employment to a few cases, for he says it is unsuitable for adherent growths with infection of the bowel wall and adjacent tissues, for large growths associated with infection, for ob-structing lesions, and for growths in the sigmoid in obese patients with short mesenteries. He recommends for some of these cases a modified procedure preceded by a transverse colostomy. Richardson,[10] Bolling,[11] Lockhart-Mummery,[12] de Martel[13], all advocate a modified Mikulicz-type procedure in certain cases; on the other hand, Grey-Turner[14] apparently gives the method no consideration.

The alternative to an operation of the Mikulicz type is resection of the lesion, with immediate anastomosis by either simple suture or by one of the two-score-odd aseptic methods, which as Rankin says, have been described, either as a complete operation, or accompanied or preceded by some form of temporary intestinal drainage. The experience at the Peter Bent Brigham Hospital is offered as an aid to understanding and solving these disputed points.

Eleven resections of the transverse colon have been made with two deaths —a mortality of 18.1 per cent. Nine of these resections were made by direct suture anastomosis, end-to-end—of these eight recovered and one died; two were made by the Mikulicz method, of whom one recovered and one died. Among the eight successful suture anastomoses three had a preliminary safety-valve cæcostomy and five did not; the hospitalization of these patients aver-aged 31.2 days. The one fatality was due to adhesions of the small intestine to the suture line, with kinking and obstruction; this patient had had a prelimi-nary cæcostomy, and inasmuch as the adhesions were presumably due either to local infection at the time the anastomosis was made, or to subsequent slight leakage, it may be argued that if a proximal colostomy of complete type could have been made, to divert completely the fæcal current and permit cleansing

of the bowl before the resection, this fatality might have been avoided. Of the two patients in whom a modified Mikulicz procedure was done, one survived and one died. The successful case had a simultaneous cæcostomy, in spite of which there were endless complications, a hospitalization of ninety-nine days and final discharge with a fæcal fistula. The fatal case was a desperate one of involvement of the stomach, jejunum and sigmoid in primary carcinoma of the transverse colon; four simultaneous resections were made with suture anastomoses in three and a Mikulicz procedure on the colon; the operation was done in an infected field owing to the presence of a fæcal fistula and death was due to peritonitis apparently from this cause. No operative method could have availed in this case. This small group of transverse-colon cases furnishes little evidence in favor of the Mikulicz type of procedure but suggests that the best available method is to make a preliminary cæcostomy and a subsequent resection with end-to-end suture, although it is likely that the cæcostomy is of little importance unless obstruction exists.

It is in the group of resections of the distal colon, from, and including, the splenic flexure to the third sacral segment, that the proper selection of various operative methods is most difficult and important. There were fifty-three resections of the distal colon for carcinoma, with forty-five recoveries and eight deaths—a mortality of 15 per cent. In eleven of these patients, the lesion was too low to permit of any form of anastomosis and a permanent colostomy was made; with one death, giving a mortality of 9 per cent. In twenty-six instances an immediate end-to-end suture anastomosis was made with twenty-two recoveries and four deaths—a mortality of 15.3 per cent. In sixteen instances a modified Mikulicz procedure was carried out, with thirteen recoveries and three deaths—a mortality of 18.7 per cent. The circumstances attending the fatalities may be compared as follows:

### Mikulicz Procedures:

Case S. 23519.—Resection descending colon; hypertension, myocarditis, chronic nephritis, hepatic metastases, death in one hour from shock.

Case S. 32850.—Resection of splenic flexure, death in three days, apparently cardiac.

Case S. 31188.—Resection of sigmoid; death in four days from peritonitis due to leak at site of Mikulicz operation.

### Direct Suture Anastomosis:

Case S. 16555.—Resection of splenic flexure, metastases in liver, death from peritonitis from defective cæcostomy, made simultaneously.

Case S. 24993.—Resection of descending colon with simultaneous transverse colostomy; death in three and one-half months from myocarditis and pneumonia.

Case S. 26063.—Preliminary cæcostomy, resection sigmoid; death in seven days from leak at anastomosis.

Case S. 10530.—Resection sigmoid, simultaneous cæcostomy; death in five days from ileus and local peritonitis.

An interesting inquiry is as to the comparative length of hospitalization of patients operated on by the suture anastomosis and Mikulicz methods, and their condition on discharge. The twenty-two successful resections of

711

the distal colon made by suture anastomosis remained in the hospital an average of 43.3 days; the thirteen successful Mikulicz cases stayed an average of fifty-three days. 'Among the suture-anastomosis cases 50 per cent. were completely healed on discharge and 27.2 per cent. had a fæcal fistula; (the remainder had granulating wounds or sinuses); whereas among the Mikulicz cases only 30.7 per cent. were completely healed on discharge and 53.8 per cent. had a fæcal fistula. As giving some evidence of the comparative general character of these groups, it may be added that 63.6 per cent. of the suture-anastomosis patients were completely obstructed on admission, contrasted with 46.1 per cent. of the Mikulicz cases. If the distal colon and transverse-colon cases were combined, constituting a larger group where both the suture-anastomosis or Mikulicz procedure are applicable, the evidence appears to be even more in favor of the former. The average hospitalization of the suture group is forty days; that of the Mikulicz series is fifty-six days; the incidence of fæcal fistula is 20 per cent. for the suture cases and 57.1 per cent. for the Mikulicz; the mortality is 14.2 per cent. compared with 22.2 per cent. In further comparison of these two methods the reviewer of the hospital records cannot fail to be struck by the frequent mention among the Mikulicz cases of pain occasioned by the application of clamps, the necessity of re-application of clamps, and the annoying infection of the wounds. In some confirmation of the general impression of the fallacy of statistics it may be mentioned that in the early days of the hospital four resections were done by the original Mikulicz method with good recoveries and average final results.

A question which has been of especial interest to the writer for some years is that of the relative efficacy of a cæcostomy or colostomy of temporary type made with a tube which necessarily diverts only a part of the fæcal current and acts as a safety-valve to prevent gaseous distention, and a proximal colostomy of permanent type which completely diverts the bowel contents. In theory, the former is easier to make, gives sufficient escape of the fæcal current to safeguard the anastomosis and will close spontaneously, while the latter is harder to make, is unnecessarily complete in its function and always requires formal operative closure. The writer believes that all but the last of these assertions are frequently untrue, and that the permanent type colostomy as a preliminary to all resections with suture-anastomosis of tumors of the colon distal to the mid-point of the transverse colon is the operation of choice. In this viewpoint he is probably greatly in the minority since most surgeons perform the temporary cæcostomy or colostomy as a matter of course. Pfeiffer and Smyth,[15] however, and Judd[2] advocate complete diversion of the fæcal stream and irrigation of the distal colon to cleanse it before resection, and Gordon-Taylor[5] has already been quoted as doing a complete cæcostomy. Rankin[7] states that operative closure of a colostomy is a much more formidable procedure than of a cæcostomy. For some years the writer has practised the permanent type colostomy in suitable cases as

a preliminary drainage operation and has found it both satisfactory in its immediate results and not difficult to close.

The experience of the Peter Bent Brigham Hospital throws a good deal of light on this question. Among thirty successful resections of the colon distal to the hepatic flexure, with suture-anastomosis, there were nine preliminary and one simultaneous cæcostomies. Of these patients no less than four had a fæcal leak at the anastomosis and two required operative closure of the cæcostomy. There were four instances of colostomy of temporary type (not diverting the entire fæcal stream), of which no less than three had gross fæcal leaks at the point of anastomosis, one had local infection and three had to have secondary operative closure of the colostomy. One of these supposedly temporary type colostomies became a permanent fæcal fistula which the patient would not return to have closed. In other words among these fourteen patients, in 50 per cent. there was failure on the part of the safety-valve to prevent fæcal leakage at the anastomosis and in 42.8 per cent. it was necessary to make operative closure of a stoma which is supposed to heal spontaneously. On the other hand, there were eight instances of preliminary colostomy of permanent type, completely diverting the fæcal stream, of which none had fæcal leaks at the anastomosis, and three had slight local infection. In closure of these colostomies three healed per primam and only one had a slight fecal leak, which does not seem to bear out Rankin's statement as to difficulty of closure. There were no deaths where resection was preceded by this type of stoma. So far as proof can be afforded by a limited number of cases, it seems very evident that a permanent-type colostomy, completely diverting the fæcal stream, is vastly superior to one of temporary type in accomplishing the object for which this preliminary operation is done. Incidentally, the surprising fact also appears that among these thirty successful resections with suture-anastomosis in the distal colon there were eight in which no preliminary or simultaneous safety-valve operation of any sort was done, yet none had any gross fæcal leak although two had complete obstruction on admission, and five had no infection of the operative wound. There was no mortality in this group. This again illustrates how misleading statistics may be, for certainly no surgeon of experience would advise as a routine, primary resection with suture-anastomosis in the distal colon without making a proximal safety-valve.

The method of suture-anastomosis adopted in the great majority of these cases was the most simple sort of open suture, consisting of an over-and-over stitch embracing all layers, supported by a continuous sero-serous stitch and with disposal of the omentum about the suture line. In no case has any special instrument or device been used, and in only a few instances has any aseptic method such as that of Kerr been employed. In the closure of the permanent-type colostomy the bowel is carefully dissected free from skin, areolar tissue, aponeurosis, muscle and the edge of the peritoneum, but the free peritoneal cavity is not entered. If but a small opening was made originally in the bowel the mucosa will be found much everted. If now the

delicate white linear cicatrix which has formed at the edge of the incision in the bowel wall and which now tends to constrict and maintain it in eversion is carefully dissected off, the mucosa can be readily turned in and a surprisingly small opening remains to be closed by a two-layer catgut suture. A folded bit of protective tissue should be carried down just through the aponeurosis, and the wound otherwise closed in layers.

The scrutiny of this group of cases of resection of the colon for carcinoma has gone far toward confirming opinions which have gradually crystallized in the writer's mind and which for some years he has been adopting in practice. The particular doctrine which he wishes to support and which seems to him to be justified by the experience quoted above, is that a colostomy of permanent type, made as a preliminary or first-stage operation in resection of the distal colon, and later closed when its work is accomplished, is much superior to the tube-drainage, temporary type of procedure. Its advantages are that it completely diverts the fæcal contents, which gives the best possible relief of obstruction; it permits the cleansing by irrigation of the operative field in the distal colon so that something akin to an aseptic resection and anastomosis may be done—whether by open suture or by some special technic—it absolutely prevents any strain on the suture line by distention by gas and fæcal matter, and any soiling from the same source. Its disadvantages may be alleged to be greater difficulty in execution, and the necessity of formal closure. As a matter of fact, it is no more difficult to make a permanent than a temporary type of colostomy; it occasions less wound infection, and as already pointed out its closure—for which no anæsthesia except local infiltration is necessary, is not difficult. There is no reason why in favorable cases the colon at the seat of the proposed resection may not be rendered practically aseptic. If the lesion has caused obstruction and much fæcal material has accumulated proximal to it, but distal to the colostomy, difficulty may be experienced in clearing it out, but usually with the rest afforded by the colostomy and the consequent subsidence of œdema and inflammation the passage of the bowel contents, softened by appropriate means, can be secured, and in any event if it remains in the colon it will not threaten the anastomosis until healing is complete and the colostomy closed.

An attempt may be made to formulate a plan for the selection of the appropriate operation for carcinoma of the colon, on the basis of the experience above recounted, as follows: in a lesion of the right colon from the ileo-cæcal valve to a point beyond the hepatic flexure, the entire right colon should be removed and a suture anastomosis made between the end of the ileum and the side of the colon; a provisional proximal jejunostomy may be made by the Witzel method, but is probably unnecessary. In carcinoma of the transverse colon, a cæcostomy should be made, using a large-calibre rubber tube, followed after its function is well established, by resection of the lesion and end-to-end anastomosis by any recognized method of suture. Probably the cecostomy may be omitted with slight risk. In lesions of the

714

distal colon, including the splenic flexure, a permanent-type colostomy should first be made in the transverse colon, through either the right or left rectus, but preferably the former, and after obstruction has been relieved, the function established and the distal bowel rendered as aseptic as possible, a resection of the lesion with end-to-end anastomosis by the suture method should be done. The colostomy may be closed under novocaine anæsthesia after eight or ten days. If the carcinoma is situated far distal in the sigmoid, anastomosis may be impossible, in which case after resection, if the proximal end cannot be brought down to the anus, the distal end is closed and dropped back and the open end of the upper segment brought out as a permanent anus. If the lesion is still more distal it will come in the category of a rectal carcinoma and will presumably require complete abdomino-perineal extirpation. If the patient is admitted with complete obstruction and it is impossible to determine the site of the lesion, it is the writer's practice to make a transverse colostomy through the right rectus under novocaine, on the theory that in the great majority of cases colonic carcinoma will be found distal to that point, and that a proximal lesion is not likely to cause obstruction. If the transverse colon is found collapsed at that point, it is wise to enlarge the incision and explore, since the lesion is likely not to be in the colon at all, but to be in the small intestine and to require immediate radical treatment. If after the obstruction is relieved a barium enema and other diagnostic measures reveal a distal lesion which is inoperable and which is best relieved by a sigmoidostomy, no chagrin need be felt at the failure to provide this at first, since the exploration and sigmoidostomy will be performed much more safely as a second stage. Finally, operative campaigns based on the Mikulicz procedure seem to the writer to be inferior to the plan above outlined on the score of mortality rate, length of hospitalization, comfort of the patient and incidence of complications. They should be reserved for certain special conditions and emergencies where they are obviously indicated.

## REFERENCES

[1] Bell, Leo P.: Carcinoma of the Large Bowel; Choice of Operative Procedure. Arch. Surg., vol. xx, p. 491, 1930.

[2] Judd, E. S.: Lesions of the Colon Treated Surgically. South. Med. J., vol. ii, p. 75, 1924.

[3] Rankin, F. W.: Choice of Operation in Cancer of the Colon. J.A.M.A., vol. lxxxiii, p. 86, 1924.

[4] Goetsch, E.: Diagnosis and Surgical Treatment of Carcinoma of the Colon. Arch. Surg., vol. xviii, p. 998, 1929.

[5] Gordon-Taylor, G.: Factors for Safety in Surgery of the Colon and Rectum. Proc. Royal Soc. Med., vol. xxiii, pp. 62-71, 1930.

[6] Coffey, R. C.: Discussion of Paper by J. S. Horsley on Carcinoma of the Colon. J.A.M.A., vol. xciii, p. 1372, 1929.

[7] Rankin, F. W.: Surgery of the Colon. New York; Appleton, 1926.

[8] Gehrels, E.: Resection of the Colon. Calif. and West. Med., vol. xxxiii, pp. 568–572, 1930.

[9] Sistrunk, W. E.: The Mikulicz Operation for Resection of the Colon. Trans. Am. Surg., Assn., vol. xlvi, p. 281, 1928.

[10] Richardson, E. P.: Diagnosis and Principles of Treatment of Carcinoma of the Colon. N.E.J. Med., vol. cciii, pp. 455–458, 1930.

[11] Bolling, Richard W.: Carcinoma of Left Colon. S. Clin. No. Am., vol. ix, pp. 733–740, 1929.

[12] Lockhart-Mummery, P. E.: Diseases of the Colon and Rectum and Their Surgical Treatment. London; Baillière, Tindall and Cox, 1923.

[13] deMartel, T.: Colectomy for Cancer. Proc. Roy. Soc. Med., vol. xxi, p. 1807, 1927–28.

[14] Grey-Turner, G.: Cancer of the Colon. Lancet, vol. ccxvi, p. 1017, 1929.

[15] Pfeiffer, T. B., and Smyth, C. M.: Carcinoma of the Colon. S. Clin. No. Am., vol. viii, pp. 869–876, 1928.

# INTESTINAL OBSTRUCTION FROM CARCINOMA OF COLON

## By William D. Haggard, M.D.

### of Nashville, Tennessee

THE highest death-rate in intestinal obstruction from all causes is from carcinoma of the colon. It is between 40 and 50 per cent. Souttar reported that in seven London hospitals during 1920-1924, the mortality rate was 43.5 per cent., and only exceeded by that of intestinal obstruction due to gallstones which was 50 per cent. Obstruction is the ultimate symptom of a large majority of cases of cancer of the colon. Carcinoma if often silent until it is considerably advanced and obstruction may be the inaugural symptom. Carcinoma generally kills by obstruction. Burgess found that 35.6 per cent. of his cases came to the hospital with complete obstruction. With symptoms of acute obstruction, when obvious causes like hernia can be ruled out, one can suspect the colon in elderly people as being the cause. If it is in the colon, 90 per cent. are due to carcinoma. Practically all lower left-sided lesions have some degree of obstruction, and as regrettable as it is, obstruction is the most significant single diagnostic manifestation.

Complete intestinal obstruction should be said to exist when obstipation for a period of two or three days with pain, vomiting and distention persists after two turpentine clysta. There may be one or two stools from enemata below the block, but after that no fæces or flatus escapes and the colicky pain is undiminished. The picture is not as clear cut or absolute as obstruction of the small intestine by adhesive bands or strangulation. There is not so much shock or vomiting, there is not the fatal loss of chlorides and there is also the absence of the dangers of circulatory constriction resulting in gangrene. Obstruction of the colon is none the less deadly.

Visible peristalsis should be sought for and any reasonable time spent in looking for this important sign is well worth while. It is relatively early and may be obliterated later by distention and paresis. Vomiting is late in appearing. The lower the obstruction, as is well known, the less the vomiting and contrariwise. Vomiting occurs in about one-half of the cases. Pain is not so compelling in colonic obstruction as in ileus, but should not be silenced with morphine until it has told its tale. It is characteristically below the umbilicus in colon obstruction, save in the ileocæcal zone. Pain was the chief symptom in sixty-five of 102 cases without obstruction (Morrison). Catharsis, while not so murderous in blockage of the large gut, is nevertheless well-nigh brutal. It intensifies the pain and may precipitate perforation.

The near aphorism that epigastric distress is more prone to originate in the cæcum and right half of the colon than it is the stomach, should at least arouse our suspicion.

717

The symptoms of carcinoma are notoriously inconspicuous. Prior to the onset of obstructive phenomena bearing on the diagnosis there are some points in the history that if present are significant. The most important is change of intestinal habit lasting from a week to a month. Among the others are abdominal distress, dyspepsia, occult blood, weakness and anæmia, urgency with futile attempts, palpable tumor in the right side, loss of weight and strength, constipation, blood and mucus. When low down in the rectosigmoid area, the partial obstruction may cause the classical compensatory diarrhœa. The duration of carcinomatous growth before recognizable in men is 7–8 months; in women 8–9 months. (Morrison.)

When there is any type of intestinal dysfunction, such common and all-pervading symptoms as constipation and diarrhœa are probably dismissed with less careful inquiry and investigaton than any other one presenting symptom.

Prior to obstruction, progressive constipation exists in from one-fourth to one-half of the patients in the presence of a low left-sided lesion.

The question may well be asked how long should constipation be treated symptomatically without an examination and without thought of its mechanical cause? Moynihan says: "In left colonic growths, constipation is the rule, while in right colonic growths constipation is rare."

*Chronic intestinal obstruction* probably exists in a greater or less degree in 40 per cent. of the cases, when seen by the surgeon. When not well marked, it can only be inferred by the intestinal distention with cramps and irregularity of bowel movement. Sometimes the patient has a definite sensation of stoppage of the fæcal flow at a certain point which he will indicate. Moreover, the gurgling of gases through the stenosed area is audible and should be listened for.

Cases diagnosed rather cavalierly as "intestinal indigestion" on account of bloating and mild distress, often mean carcinoma. Chronic appendicitis, a diagnosis which always requires support and creates suspicion, may, in an elderly person, be a masquerade for carcinoma. Medical treatment is a positive disadvantage because restricted diet and mineral oil unfortunately obviate the pain that a generous diet and a lack of solubility of stools would produce, which would necessitate a more careful investigation. Partial obstruction associated with abdominal cramps and urgency of bowel movement, perhaps with diarrhœa, is sometimes associated with streaking of the stool with blood. This would be the colloid, adeno-carcinoma, with ulceration and resulting fixation and tumefaction. Partial obstruction over several days temporarily relieved by enemata, may recur after days or weeks and sometimes months of relative freedom, only to reappear with redoubled vigor or with complete obstruction.

Visible peristalsis is not as appreciable in the large intestine as it is in the small and can be, of course, seen more easily in thin subjects and when seen is of a sluggish undulation more prolonged. In the low, recurring type of partial obstruction, not due to annular constriction, the patient may bear

the complete obstruction with comparatively few symptoms except increased, persisent, and continuous distention of the abdomen.

One thinks of the stomach as being the most frequent site of carcinoma. The large intestine, including the rectum taken as a system, produces more carcinomata than the stomach itself. Approximately half are in the rectum and the other half in the colon. Of those in the colon 50 per cent. are in the sigmoid, nearly a third in the ascending and transverse and the smallest number at the flexures which are the fixed portions. The large intestine down as far as the splenic flexure develops from the primitive mid-gut with the flexity and absorptive properties of the small intestine. Hence large growths can exist in the right half of the colon for long periods without obstruction. The descending portion develops from the primitive mid-gut. Here absorption is near completion, the excreta is dehydrated and more solid and the function of the left half of the large intestine is largely storage. Practically speaking, it may be said that tumors from the cæcal region to the splenic flexure are associated with diarrhœa and severe anæmia. Whereas those below the splenic flexure are associated more with constipation and without anæmia.

The large, flat, fungating, soft encephaloid types of tumors in the cæcum and ascending colon rarely ever produce obstruction. Whereas the stenosing, fibrotic type or so-called napkin-ring carcinoma on the left side of the colon is very prone to produce gradual constriction of the lumen with increasing although undetected symptoms of partial obstruction until it finally becomes complete. The large tumor at the head of the cæcum is sometimes felt by the patient himself and is a fortuitous circumstance. Such a patient of ours who had no other abdominal symptom whatever resulted in a five-year cure so far. A mass that is palpable is not a sign of inoperability any more than it is in carcinoma of the stomach. There is often a spool-like lesion with no lymphatic involvement. With symptoms frankly suggestive of obstruction, Röentgen-ray as a rule is not required. Valuable time should not be lost. If convenient, and the condition of the patient will permit, a barium enema may be given and a plate quickly made.

The redundancy of the sigmoid and it being sequestered in the bony pelvis, sometimes offer difficulties whereby the filling defect in the narrow canal, surrounded by the growth, may be entirely obscured by an overlying loop of sigmoid. This taxes the skill of the röntgenologist, but with care, experience, manipulation and palpation, this can be obviated. The skilful employment of the fluoroscope is more revealing than the plates.

A barium enema is much preferable to the barium meal from above which may be a menace in chronic obstruction because in a partial obstruction the lumen may become quite closed and plugged by a mass of barium.

A bimanual rectal examination may sometimes be rewarded by the location of a low-lying growth and should be routinely and searchingly made.

I once reported a group of five cases of complete intestinal obstruction from carcinoma of the rectosigmoid and rectum which had not been previ-

ously diagnosed or even examined by digital method. Failure to examine the rectum not only for suspicious symptoms but in a routine physical examination is one of the scandals of our diagnostic errors. Low-lying growths can be visualized by the sigmoidoscope and if possible a biopsy may be made to determine the grade of cancer and its bearing upon advice and prognosis. Surgeons may not need the admonition to use extreme gentleness. Gray Turner refers to five cases in his knowledge of perforation of the sigmoid by the sigmoidoscope, one in his own hands resulting fatally although immediate abdominal section and suture were carried out. In unlocalized obstruction the blind cæcostomy, under local anæsthesia without exploration, is the procedure of choice.

Obstruction occurs six times as often on the left half of the colon, in the experience of Burgess, as it does in the right half—87 per cent. versus 13 per cent. A simple colostomy, however, is a serious undertaking as in the Brigham Hospital series the mortality was 39.1 per cent. and Gray Turner's was 39 per cent. Resections in both of these clinics were about 19 per cent. only. With preliminary colostomy it was 9½ per cent. and without it was 35½ per cent.

The permeability of the diseased gut, with the trauma of the handling, invites an exudate of virulent microörganisms. This largely explains the higher death-rate of palliative colostomy. The amount of manipulation required to determine its obstructiveness and the future operability is ill-timed. It sets free the highly septic flora of the obstructed growth and sets up a degree of peritonitis that in aged, debilitated, dehydrated patients is so often fatal. It is the toxicity of the imprisoned secretions above the obstruction that gives the added danger to exploration. Thus in a small number of acute obstructions at the Mayo Clinic, the mortality for colostomy was 42.85 per cent., whereas palliative colostomy, on account of inoperability, gae a mortality of 7.67 per cent. and colostomy in the group where further operation was considered advisable was only 2.7 per cent. Generally speaking the "blind cæcostomy" proposed by Stiles in the acutely ill and completely obstructed patient is wise and safer surgery. The Gibson type of cæcostomy with a three-quarter-inch tube is satisfactory.

With spinal analgesia and a moderate Trendelenburg position, in not too obese subjects, the parietal wall can often be elevated and mobilized sufficiently to visualize the lesion without the danger of unwarranted and dangerous exploration to determine the location.

If any exploration at all is done, the general abdominal examination, liver, etc., should be alone carried out. In any event it should precede even the most superficial examination of the growth. Everyone can recall instances where only an exploration to determine the site and character of the lesion would have prevented disaster. Therefore spinal analgesia, and its amazing relaxation, allowing visualization, is a most helpful substitute for manipulation.

In partial obstruction, where the growth is inoperable, short-circuiting is in some instances preferable to colostomy. It will overcome the future attacks of painful near-obstruction and is preferred always by the patient to colostomy. Partial obstruction, where not too severe, can sometimes be well treated by anastomosis, say between the transverse and pelvic colon without resection. Rowlands reports a successful subsequent removal of a resultantly shrunken growth in the splenic colon in these circumstances. Splenic growths are obstructive in 100 per cent. Where no secondary removal is possible internal anastomosis is in some instances more desirable, even though bought at a slightly greater hazard. The mortality of colo-colostomy or ileocolostomy is approximately 30 per cent.

Colostomy of the modified madyl type with a muscle split incision low down on the left side in front of the anterior superior spine is perhaps the simplest.

Rankin suggests returning the excess of the distal colon back into the incision and pulling up on the proximal until a fixed portion is reached near the junction; obliteration of the opening to the outer side of the colon by a purse-string suture to the lateral fold of the peritoneum, sewing it to the parietal layer to prevent the foramen being left patulous; suture of the peritoneum and also the abdominal skin under the protruding arch of the sigmoid; suture of the fascia loosely, and lastly the avoidance of handling the growth as peritonitis causes half of the deaths.

Resections at the Brigham is 19.2 per cent., which closely parallels the result of Gray Turner's—19 per cent. operative mortality.

Resection with preliminary colostomy gave 9.6 per cent., whereas resection without preliminary colostomy 25.5 per cent. Preliminary colostomy is not so applicable to colonic growths, but it can be profitably done in two stages. One can proceed to resect even in the presence of liver metastasis. The risk is not much greater and life was prolonged on an average of seventeen and one-half months. "A resection is often the best palliation," says Gray Turner.

The Mikulicz-Paul operation in the movable part of the colon, may be employed in partial obstruction with satisfaction. The obstructive resection obviates possibility of cancer implant in the wound.

Bolling reported thirty-three cases of Mikulicz' operation at St. Luke's with two deaths. Cheever reports 16.1 per cent. mortality for resections with complete obstruction and 21 per cent. mortality without complete obstruction, which means that the cases with complete obstruction probably had, of necessity, preliminary colostomy. "Obstruction may be regarded as actually a favorable complication." (Cheever.)

# SURGERY OF THE LARGE INTESTINE

## By William J. Mayo, M.D.

### of Rochester, Minnesota

I have been asked by the officers of the American Surgical Association to present a paper on surgery of the large intestine, based on the records of the Mayo Clinic from the first radical operation, in 1890, to January 1, 1931. In this period, 5,426 operations were performed on the cæcum and ascending colon, transverse colon, sigmoid, and rectosigmoid, and 3,312 on the rectum. In reviewing this mass of data representing forty-one years of a developing field of surgery, one finds much of interest but also much which would take up time unprofitably.

In an endeavor to deal with so large a mass of statistics of operations performed by several surgeons over a long period, it is difficult to do more than to state generalities, and these generalities should not be granted such weight as the number of cases reported might indicate, lest significance be attached to quantity rather than to quality. It should be remembered that reports of smaller groupings of statistics presented by surgeons who have worked up their cases in great detail from every standpoint might in many respects have greater significance than composite statistics such as I might present.

The statistics given in detail in the accompanying charts, for which I am indebted to Dr. Fred W. Rankin, are for the years 1929 and 1930. For the earlier years from 1890 to 1929, I shall content myself with brief historic comments on the growth of our knowledge in this field.

First I should like to direct attention to some of the physiologic and anatomic facts which have been developed in this period largely through clinical investigation and research. The significant fact to be deduced is the gradual change from surgery controlled by gross pathology to surgery based on physiology. It should be noted that the understanding of early processes which lead to the late manifestations of disease which controlled surgery in the past is helping us to a broader comprehension of disease in its earlier stages and consequently an increased percentage of cures. In this better knowledge the Röentgen-rays and various forms of endoscopic examination are playing a remarkable part.

*Physiologic and Anatomic Considerations.*—In any consideration of an organ we always think of anatomy as fundamental, but in reality physiology is the architect which designs the anatomic structure.

Embryologically, the colon has its origin on the left side of the body, and the small intestine in six primary convolutions on the right side. At about the eleventh week the embryonic colon begins to move to the right, and continues to move until the head of the colon reaches its normal situation soon after birth. The right half of the colon originates with the small intestine

from the mid-gut, having in the embryo the same villi, and it retains the same blood supply from the superior mesenteric vessels as the small intestine. Comparative anatomy indicates that a small proximal colon is characteristic of the carnivora, and unabsorbed end-products of protein metabolism undergo putrefaction, whereas in the herbivora the huge proximal head of the colon with its silo-like capacity is for the purpose of extracting carbohydrates from the herbivorous diet, the unabsorbed end-products undergoing fermentation. In man we see in the moderate size of the cæcum and ascending colon a characteristic feature of the omnivora; its purpose is to remove nutritive material from protein, fats and carbohydrates, the unabsorbed end-products of which undergo both putrefaction and fermentation, and in these processes lies the possibility of development of toxic products, the absorption of which may be the cause of certain disorders. We see manifestation of this possibility of toxicity in the anæmia which so often is evident in connection with tumors of the proximal half of the large intestine. Often œdema of the lower extremities is present, with other signs and symptoms which fortunately do not have the same prognostic significance as similar conditions in other parts of the body, since many of these debilitated patients are to be cured by radical surgical procedures.

Recent investigations by Alvarez and his colleagues have shown the influence of food products on mass. Among the various types of food which form a mass, such common articles of diet as potatoes and milk form relatively large masses, whereas red meats induce a large amount of bacterial action. Three-fourths of the peoples of the world eat rice for carbohydrate, and more or less fish for protein. Rice not only has a high-calorie content but also liquefies and forms only a very small mass; such articles of diet as fish also form a small mass. It would be interesting to know whether diverticulum of the large intestine is as common in the countries in which rice and fish are eaten as it is in the countries in which potatoes and red meats are eaten.

The left half of the large intestine, like the stomach and the urinary bladder, has a reservoir function. The absorptive power of this portion of the bowel is not great, and its peristalsis is largely reverse except during defecation, to move the products back into the absorptive part of the large intestine where fluids and nutritive materials may be taken up. We often speak of rectal alimentation, when we simply mean that certain materials are passed into the rectum for reverse peristalsis into the right half of the colon to take place, as food is taken through the pharynx and the œsophagus into the stomach.

Man has little consciousness of what is going on in the small intestine and right half of the colon, whereas he is more or less conscious of the action of the sigmoid.

In mammals the testis is the primitive procreative organ, and because of its long heredity it is relatively free from disease; the ovary, secondary to the testis, is a more recent acquisition which has not yet achieved the same resistance. So, too, the colon, of relatively recent development, has not yet achieved the stability of the primitive small intestine.

The autonomic nervous system is largely independent of the central nervous system. The autonomic fibres regulate the action of the gastro-intestinal tract, and the other viscera, the ductless glands, the blood-vessels, and all organs containing involuntary muscle.

The autonomic nervous system has for one of the most important tissues under its control the non-striated muscle, which was probably the oldest of all forms of control. Then came the internal secretions followed by the sympathetic nervous system; the internal secretions might be said pictur-esquely to play on the sympathetic nervous system to produce its results as hands and fingers play on the piano. This association with the non-striated muscle is well shown in the intramural plexuses of the gastro-in-testinal tract, as described by Keith, and again by intestinal peristalsis, several contractions to the minute, and that vascular type of peristalsis which occurs eighteen to twenty times a minute and acts as the heart of the portal circu-lation to the liver.

Gaskell described the small, round, medullated nerves which connect the anterior horns of the spinal column with the great sympathetic nodes, all of which are direct connections, except those which pass to and through the suprarenal glands before reaching the ganglions, showing the close connection between the important internal secretion of the suprarenal glands and the sympathetic system. Langley described the parasympathetic nerves, the vagus and pelvic nerve.

We begin to see that certain obscure happenings in connection with the large intestine may be due to localized spasms of the smooth muscle layer of the blood-vessels. Again, now that we are getting new light on the sympa-thetic nervous system, which acts as a brake on intestinal peristalsis, we see a possible explanation of some phases of the development of diverticulosis. Learmonth and Markowitz have shown that after section of the inhibitory nerves to the colon of the dog, a barium meal may produce an appearance suggestive of early diverticulosis.

The work of Hunter and Royle has stimulated fresh surgical interest in the sympathetic nervous system. In this field Adson, Rowntree, and their associates have been able to relieve megacolon and similar disorders which resemble the dilated œsophagus in cardiospasm, by removal of the lumbar sympathetic ganglions and their communicating branches. The operation effects its purpose probably by leaving the sacral sympathetic outflow, which is motor to the distal part of the colon, in sole control of this part of the bowel. Such procedures have also brought about marvelous relief in Raynaud's disease, in disease of the blood-vessels of the extremities, in which one element is contraction, leading to gangrene, such as is seen in Buerger's disease, and in certain types of chronic arthritis, by removal of appropriate sympathetic ganglions and their communicating branches.

In 1909, I presented before this Association the results of some anatomic investigations which developed the fact that the external peritoneal attach-ments of the colon on the right side did not contain blood-vessels or other structures of importance and that these attachments to the lateral abdominal

wall could be readily divided, so that the colon could be freed on the right side and to a considerable extent on the left side, and drawn out of the abdomen for careful dissection under the eye. By this means the lymph-nodes were made accessible and the relations of the blood-vessels, especially the right colic and ileocolic arteries, were made clear. But that part of the colon to which the omentum was attached did not permit of this manœuvre to the same extent, especially in the high-lying splenic angle which acts mechanically to hold fluids and food in the absorbing right half of the colon.

In 1917, I presented a paper before this Association on the anatomy and surgical relationship of the rectosigmoid. The region of the rectosigmoid is of great interest; it is the most constricted portion of the large intestine, and it is here that the type of epithelium changes. The upper valve of Houston, situated immediately below the rectosigmoid, suggests that this portion of the bowel has mechanical function, and one sees why it is so frequently affected by malignant disease.

## SURGICAL COMMENTS

Of the thirty-one papers I have presented before this organization, six have been on the large intestine. And as I review these contributions to the subject under discussion, I find a picturesque history of the development of this interesting field of surgery. One of the outstanding contributions to this development was the adoption by C. H. Mayo, in 1896, of the two-stage operation for resection of the large intestine, to overcome the obstruction which to some extent is so often present, and later his modification and popularization of the Mikulicz operation. In this procedure the diseased portion of the colon, with its glands and other involved tissue, was brought outside the abdominal wall and fastened, and not removed until protective peritoneal adhesions had formed. The ends of the bowel formed at the colostomy were united later.

Of great worth also was the contribution of Balfour, who, in 1910, demonstrated the value, in primary resection in continuity of the sigmoid and rectosigmoid, of passing a tube, of the stomach-tube type, through the anus and rectum to a point 6 or 8 inches above the anastomosis, and leaving it in place for seven to ten days, to carry off the gas, to prevent angulation, and to maintain the intestinal channel in proper position. This procedure, in the absence of obstruction, often enables one to save function and to avoid the necessity of making a colostomy, either temporary or permanent.

*Benign Disease.*—In the decade from 1890 to 1900 operation was performed in the clinic in seven cases of tuberculosis of the large intestine, in five of which resection was made with truly extraordinary results. In those earlier years we saw relatively more tuberculosis of the intestines than in later years. The hyperplastic ileocecal coil, like the old types of disease of the bones and joints, was largely the result of the bovine type of the bacillus of tuberculosis carried in milk, and as the years have brought pasteurized milk, these types are disappearing.

In 1907, Wilson, Giffin and I reported five cases in which a portion of sigmoid was excised for obstructive diverticulitis, with formation of tumor.

These were the first instances recorded in which an actual demonstration of the pathologic change in diverticulitis was made during the life of a patient. I presented a paper on diverticulosis at the last meeting of the Association (1930), and I have nothing of importance to add to the subject.

*Malignant Disease.*—C. H. Mayo taught us to wrap the colon with the omentum in cases in which the blood supply was seriously injured, and also to use the omentum to protect the anastomosis in resections as far as possible, sometimes drawing the colon through an artificial opening in the omentum and attaching it to the parietal peritoneum, so that if perforation occurred at the site of union, the peritoneal cavity would be protected.

In surgery of the sigmoid the anatomic relation of the ureters in the pelvis must be taken into consideration. On the left side, especially, the ureter may be and often is so closely attached to a growth in the lower part of the sigmoid that it cannot be separated without the possibility of leaving a portion of the growth with the adherent ureter. In my first case of this character, after a difficult operation, finding an otherwise normal ureter closely attached to the involved sigmoid in a removable malignant growth, I cut and tied it at the brim of the pelvis and removed the lower part of the ureter with the growth, intending to remove the kidney at the same time. The condition of the patient did not permit such a manœuvre, but I expected to be compelled to remove it when the patient was sufficiently recovered. I found, to my surprise, that no ill effects followed. The patient lived more than eight years in good health, and died from another cause. Since that time, on similar occasions I have not hesitated to tie and cut a normal ureter, bringing about dysfunction and atrophy, and without harm. I have no doubt that accidental cutting of a ureter happens occasionally on one side in performing hysterectomy without any one's being the wiser.

In 1917, I first performed transperitoneal sigmoidotomy for removal of a bleeding papillomatous growth, and found it very easy of accomplishment. After incising the sigmoid, the growth, which was single, was brought out of the sigmoid and the cone of normal mucous membrane at the base was ligated and cut with the cautery. The sigmoid was closed and the wound was closed without drainage. We have had a number of cases of this general description without a death, and have found the procedure much safer in every way than resection. None of the patients has had further trouble.

It frequently happens that in the course of an exploration because of carcinoma, the finding of enlarged lymph-nodes has acted to interrupt a radical operation. Unless such a node is removed and shown to be carcinomatous, the conclusion that excision is useless is not always justified. In many instances we have operated on patients who have had such explorations and have found at later operation that the nodes were not carcinomatous, and radical operation was performed successfully.

There are some exceptions to the inadvisability of radical operation for incurable carcinoma, the chief of which is removal of an operable primary growth when secondary growths are present in certain situations—for instance, in the liver. The liver has the greatest power of regeneration of

726

any organ in the human body. In three operations several months apart the entire liver of a dog can be removed, as shown experimentally by Mann, with eventual complete regeneration. When carcinomas of the stomach, rectum, or large intestine are safely removable locally, it is sometimes advisable to excise the primary growths as a means of palliation and to prolong life, thus enabling painless secondary processes to bring about the fatal issue rather than the original processes to result in painful death. Metastatic processes in the liver have room for enlargement without infection or pressure on neighboring organs, nerves, and tissues, and the patient may live for many months comfortably and then die painlessly. It has been pointed out by specialists in tuberculosis that if the primary lesion can be removed or cured, the secondary lesions are more readily cured or delayed in growth than is the primary lesion. This may also be true to some extent of malignant disease.

## REFERENCES

[1] Balfour, D. C.: A Method of Anastomosis Between Sigmoid and Rectum. ANNALS OF SURGERY, vol. li, pp. 239-241, February, 1910; Coll. Papers Mayo Clinic, pp. 297-300, 1910; The Utility of the Rubber Tube in Intestinal Surgery. Surg., Gynec., and Obstet., vol. xxxi, pp. 184-192, August, 1920.

[2] Mayo, C. H.: Cancer of the Sigmoid and Rectum. Surg., Gynec., and Obstet., vol. iii, pp. 236-241, August, 1906; (With W. Walters) The Two-stage Mikulicz Operation for Cancer of the Sigmoid. Surg., Gynec., and Obstet., vol. xxxix, pp. 1-4, July, 1924.

[3] Mayo, W. J.: Localized Tuberculosis of the Intestine: with a Report of Seven Operated Cases. New York Med. Jour., vol. lxx, pp. 253-258, August 19, 1899; Surgery of the Large Intestine: with a Review of 100 Resections. ANNALS OF SURGERY, vol. l, pp. 200-228, July, 1909; Tr. Am. Surg. Assn., vol. xxvii, pp. 310-344, 1909; Radical Operation for the Cure of Cancer of the Second Half of the Large Intestine, not Including the Rectum. Jour. Am. Med. Assn., vol. lxvii, pp. 1279-1284, October 28, 1916; Coll. Papers Mayo Clinic, vol. viii, pp. 331-343, 1916; Transperitoneal Sigmoidotomy for the Removal of Tumors in the Mucous Membrane. ANNALS OF SURGERY, vol. lxvi, pp. 64-68, July, 1917; A Study of the Rectosigmoid. Surg., Gynec., and Obstet., vol. xxv, pp. 616-621, December, 1917; Tr. Am. Surg. Assn., vol. xxxv, pp. 177-185, 1917; Diverticula of the Sigmoid. ANNALS OF SURGERY, vol. xcii, pp. 739-743, October, 1930.

[4] Mayo, W. J., Wilson, L. B., and Giffin, H. Z.: Acquired Diverticulitis of the Large Intestine. Surg., Gynec., and Obstet., vol. v, pp. 8-15, July, 1907; Tr. Am. Surg. Assn., vol. xxv, pp. 237-254, 1907.

DISCUSSION.—DR. J. SHELTON HORSLEY (Richmond, Virginia) said this has been an extremely interesting group of papers. He said Doctor Cheever has shown very clearly in his statistics the indication for an enterostomy before resection of the colon. He believed that the enterostomy should be complete, using the old operation, bringing the bowel onto the abdominal wall and putting a glass rod under it. This is done through an extended McBurney incision, mobilizing the cæcum and ascending colon if necessary in order to bring it to the abdominal wall.

Ten days after the enterostomy the resection may be done, and the bowel will be found contracted, containing no fecal matter, and having comparatively few bacteria.

Ten days after the resection the enterostomy is closed. This closure of the enterostomy is readily done, though it may appear at first to be difficult. After withdrawing the glass rod, the everted mucosa is turned into the lumen of the bowel by manipulating it, using petrolatum, and is held in the bowel by a few stitches of fine

tanned catgut. One or two other rows of interrupted sutures of the same material are placed and the ends are left long. These sutures are sometimes under tension, and under ordinary conditions would appear to be unsafe. The peritoneal cavity is then opened and the adhesions to the affected loop are separated and the bowel is dropped into the peritoneal cavity. The long ends of the suture are threaded in a needle and passed through the parietal peritoneum just above the wound. The wound is then closed loosely in layers with catgut, drainage being placed down to the peritoneum. Here sutures approximate the bowel snugly to the parietal peritoneum. If there is fecal leakage it does not occur for at least several days, and in the meantime the general peritoneal cavity has been thoroughly protected by adhesion to the parietal peritoneum. There is almost always some suppuration, but usually no fecal matter appears. In ten days after the resection has been done the union at the site of resection has probably become firm.

In one type of case, in which the patient is fat or the tumor is large or adherent, end-to-end or even lateral anastomosis is probably inadvisable. Here the Mickulicz type of procedure is doubtless best. The bowel is mobilized, the mesentery is severed and tied as though the resection were to be done immediately, and then the affected loop is brought onto the abdominal wound. Two rows of sutures appose the portion of the bowel where the spur is to be, taking care to bring together the walls of the bowel which contain no large vessels. Drainage of gauze and tubes is placed into the peritoneal cavity, reaching to the stump of the severed mesentery. The loops in the bowel are doubly clamped and divided with the electric cautery. The clamps on the stumps are left on for at least several days; the drainage is removed in two or three days. The spur is opened by applying a soft-bladed clamp such as is used for occluding the bowel during intestinal anastomosis, clamping this gently, so that only the tips at first become engaged, and then after twenty-four hours the clamp can be more firmly applied and the bowel will not slip from its grasp.

As illustrations of these two types of operations, Doctor Horsley reported these two cases:

Mrs. L. H., aged seventy-three years, was quite fat and in rather poor physical condition. The left half of the transverse colon had a large necrotic carcinomatous ulcer with some adhesions and a few large lymph-nodes. The type of Mickulicz operation that has been mentioned was done, and the patient made a satisfactory recovery.

A patient representing the type of end-to-end suture that has been described was Mrs. A. M. B., aged eighty-four years. There was an annular carcinoma of the sigmoid. A complete enterostomy with a glass tube was done on the right side, and ten days later a resection was done with end-to-end union as described. There were a few involved lymph-nodes in the mesentery attached to the resected portion of the bowel. Ten days after the resection, the enterostomy was closed. After closing the enterostomy there was rather marked bronchitis, which, for a while, seemed ominous, but she recovered from this in a few days and made a satisfactory convalescence. There was never any trouble about the abdominal healing.

Doctor Horsley felt that in every case, whatever the technic of resection is, whether there is an obstruction or not, it is important to do an enterostomy at least ten days before and to do it in such a manner that one can tie it off, and, at the same time, so that it can be easily closed later on.

DR. LEONARD FREEMAN (Denver, Colo.) said the old controversy that has gone on for so many years as to which is the better method of uniting the large bowel after a resection, as to whether it should be done end-to-end, or side-to-side, has been decided, in this country at least, pretty well in favor of the end-to-end anastomosis, in spite of the fact that the side-to-side anastomosis offers a much better field for work in the peritoneum and the blood supply is better.

He did not believe this to be properly decided. Quite recently Finnistere, in Vienna, has suggested a method by which the side-to-side anastomosis can be done with a great deal of safety. He has used a method for a number of years, and has had opportunity

in some instances to examine a case after death, and sometimes even before death. He has found results to be satisfactory.

The principal objection, of course, to a side-to-side anastomosis is the dilatation of the free end of the colon. He did not believe that that is necessary to occur; it can be avoided in a very simple way. In the first place, by making the anastomotic opening quite large, and in the second place, by making the end of the dividing cut short, so that it comes up as close to the opening as it can without obstructing the opening, and in the third place (and the most important thing), using chromic sutures to unite the free end of the bowel to the adjacent bowel—in this manner one easily avoids dilatation.

DR. EMMET RIXFORD (San Francisco) said that he had had the experience of uncovering the colon, seeing it full of obstruction or carcinoma, and as soon as the pressure, or the support of the abdominal wall was released, the peritoneum split, showing the force of the gases within the colon.

Another case of a similar sort was a woman who had been shot in the region of the spleen and developed an obstruction. The operator cut down and relieved the obstruction—at least he thought he did—but being a very conscientious man and bound to have the bowels move afterward, he gave the patient pituitrin. Such a degree of peristalsis was started up by the pituitrin that the small bowel contents were forced into the cæcum to such an extent that it burst as soon as the support of the abdominal wall was relieved. So Doctor Rixford said he was afraid of pituitrin in obstructive conditions.

In regard to Doctor Freeman's point about the dilatation of the end of the gut in a lateral anastomosis: Doctor Rixford had done a good many of them and had had no particular trouble from that source. But he would warn against making the end too short. He had one disaster just because of that. The circulation in the end of the gut had been interfered with by the operative procedure and perforation occurred.

Another point in the use of the Mikulicz method: He had the misfortune to take care of a man suffering from carcinoma of the sigmoid. It was in the early days of the Mikulicz procedure. Everything went well until they came to the point of closing the colostomy. They used the Mikulicz apparatus. After two days, perforation occurred in the peritoneum. Why? Because the superior hemorroidal artery was crushed by the forceps and obstructed, and a segment of the gut below died.

DR. FRED B. LUND remarked that he thought it to be a little safer. He had had recurrences in the abdominal wall follow, but he did not think that to be worth consideration in the case under discussion. Of course, in cases of diverticulitis, one does not have to think about recurrence. It is only in carcinoma cases that one considers it.

The method of resection which Doctor Rankin brought out does away with a great deal of the danger of the Mikulicz procedure in a good many cases.

Doctor Lund has never had any dangerous cutting through of the vessels by the clamp. Sometimes the clamp stays longer than one wants it to, and sometimes it comes off sooner than one wants it to—sometimes one does not get enough of a partition the first time—but it is the safest method in a most desperate set of cases.

DR. W. E. SISTRUNK added, in defense of the Mikulicz operation, that this operation, when it is performed in properly selected cases, is certainly a safe-and-sound procedure. The great mistake which has been made by surgeons is through their attempts to use the operation in cases in which it is unsuited. For instance, one finds in many instances a small ring type of carcinoma which is in a very long redundant type of sigmoid with a mesentery which is often six or eight inches in length. If that bowel is lifted up, if the bowel is turned and its edges sutured together so that it can be easily put down, with clamps which, when they are applied, will crush only the bowel wall and not the blood supply, a large amount of the bowel—that is, often six, seven, eight or ten inches long—with as much mesentery as one would wish to remove, can be removed. But in a case where obstruction is present with a dilated bowel and a lot of liquid material above it, and especially in case of a large, stout individual with a thick abdominal wall, who, in many instances, will be found to have a very short thick mesentery, if one attempts to drag a growth up through the incision, and has difficulty

729

in dragging it far enough out of the incision, one is very likely to have either sloughing of bowel from tension or to have metastasis occur in the abdominal wall.

On the other hand, if one finds growths which are attached laterally much inflamed, as one frequently sees these growths, and if one goes and breaks up the adhesions and tries dragging them out, and there has been a great amount of contraction from the inflammation surrounding the growth, in that type of case one will stand a large chance of having metastasis occur in the abdominal wall.

The Mikulicz operation, in the properly suited cases, is a very safe-and-sound operation; but it is often misused, and many of the bad results which one sees from it, and many of the metastases in the abdominal wall, come from efforts to use it in cases in which it is unsuited.

DR. REA SMITH (Los Angeles, California) remarked that he never felt safe with any suture line on the left side of the colon. He always felt safer when it was on the right. The reason a tube is not used as often as it should be is because it is so hard to have a nurse pass it during the operation. A great deal of trauma results and the operation is lengthened by the passing of a sigmoidscope before the anæsthetic. But placing a tube up in the sigmoid and leaving it there he finds of great value because after the suture line it can be slipped through without any trouble.

DR. DAVID CHEEVER said that for Doctor Haggard's blind cæcostomy he would substitute a high right transverse colostomy, for the reason that if the obstruction is in the colon 9 chances to 1 it is carcinoma, and if it is carcinoma 6.5 chances to 1 it is distal to that point. So if one makes a colostomy there one is going to relieve all the obstruction, completely divert the current, and give the best chance for a more radical operation at a later date. Whereas, if the lesion is carcinoma, and in the proximal colon, the cæcostomy does no good.

In regard to the Mikulicz operation, Doctor Cheever was surprised that his feeble attack on it did not bring out more objections because it seems to be so widely accepted throughout literature as, on the whole, the best procedure. The actual facts from the records of the Brigham Hospital which he quoted seem to justify him in taking the position which he did. They show, in brief, that the radical operations on the distal colon by the Mikulicz method carry a considerably higher mortality than those made by the open suture method; that the period of hospitalization is considerably longer, and that a much larger percentage were still incompletely healed when the patients were discharged from the hospital. The evidence as far as his small experience goes is very strongly in favor of the open suture resection after a preliminary colostomy, as against the Mikulicz.

Another thing, in perusing the house officers' memoranda of the subsequent cases in the hospital after the operation with the Mikulicz procedure, one constantly runs across such statements as: "Application of clamp not satisfactory"; "Clamp had to be re-applied"; "Application of clamp quite painful"; giving a distinct impression that the comfort of the patient after the Mikulicz resection is less than the comfort after the open suture resection.

To quote two authorities showing the wide divergence of opinion about the Mikulicz procedure: Coffey says, in a recent article, "Probably no more important principle has been introduced into intestinal surgery than the Mikulicz principle." And Bell, an English writer, says, "The Mikulicz procedure is grossly overvalued and should be abandoned except in certain instances."

Doctor Sistrunk, in an article on the Mikulicz method, lays down four conditions in which it is not suitable: (1) Growths with infection of the walls of the intestines. (2) Large growths which are adherent. (3) Obstructing growths. (4) Patients with short mesenteries, and whose lesion is in the sigmoid.

That is a pretty large category which he lays down, and which he says himself are not the best type of case on which to employ the Mikulicz.

He certainly doesn't want to deny that the Mikulicz operation is a very possible and often a very good way of making an anastomosis in these cases, but the number

of cases in which it is superior to the open suture method, done in the simplest possible way, preceded by a permanent type colostomy which is subsequently closed, are very few indeed.

Dr. W. D. HAGGARD said that his plea for cæcostomy was because of the ease and rapidity of its performance under local anæsthesia, and perhaps under spinal anæsthesia, and doing very little, preferably nothing at all, to the growth itself.

One must not forget that one is operating on an intestinal obstruction. A cæcostomy is a life-saving procedure, just an enterostomy in the post-operative obstruction. If one does it under local, in the patient's bed, the patient is going to get well. If one does much to him one is going to lose him.

With the big tube one can get very good drainage, but perhaps not as well as if one puts in the double barrel. There is not much objection to putting it in—it is purely a technical thing. The point is to do as little to the patient as possible, in view of the frightful mortality. The trouble is made cutting the mid-line of the transverse colon. One does not know where the growth is.

Dr. WILLIAM J. MAYO (Rochester, Minnesota) said that there is one thing one must think of after a while, and that is the colostomy. He had known good sensible men and doctors who would just as soon die some easy and convenient way as to live with a colostomy. He hoped the time is coming when one will not have to use so many permanent colostomies. He thought the time has arrived. We are struggling now to give people function, and normal function.

When one comes across the sea and one gets into St. Lawrence Bay—when one comes across that way—one has about two days; a boat comes down and one gets some mail and newspapers. Under such conditions he gets a valuable thing out of an afternoon paper. Having nothing else to do he reads it clear through, advertisements and all. The thing that interested him most was the picture of a gardener. He was pulling a wheelbarrow behind him. He had a lot of plants, pots, and one thing and another in it. There was a boy, evidently about twelve or fourteen years of age, with his books under his arm. And, thinking about the mechanics of this, he said to the gardener: "Why do you pull the wheelbarrow behind you instead of pushing it in front?" "Well," was the answer, "I hate the sight of it so."

DOCTOR JONES (Boston) said that two fundamental principles in resections of the colon are: (1) An adequate blood supply and (2) release of pressure on the line of sutures. If there is an adequate blood supply, and there is no pressure on the line of sutures, either by a colostomy or by a large tube in the cæcum, one will have no trouble. We have thought too much about the aseptic anastomosis and the kind of suture we should use, whether Pagenstecher or silk, or catgut; meanwhile, we have forgotten that it is a very difficult thing to have a proper blood supply in resections of the colon.

There are two sets of vessels. It isn't only the large vessels which can be injured. Of course, there is also the question as to whether the inferior mesentery can be tied and still have the lower portion of the sigmoid get sufficient blood supply so one can tie the left colic, the right colic, or the middle. But more important than that one should be able to tie any one of them. One must see each time that one has sufficient blood supply after one is tied.

More important are the vertical vessels from the arteries. They are terminal arteries. And that is the reason an end-to-end anastomosis is not as good as a lateral, so far as leakage goes. In doing an end-to-end anastomosis one may tie one or two of the vertical vessels. Doctor Jones had tied off two of the vertical vessels and had had necrosis of close to half an inch every time that that was done. He said it is quite easy to tie those small vertical vessels in an end-to-end suture and to get necrosis and leakage.

The other fundamental is the release of pressure on the line of sutures. It does not make a bit of difference what suture material is used or how carefully it is done— if one does not have the pressure and does have a blood supply, there will be no leakage.

# THE ACTION OF SODIUM CHLORIDE UPON THE SMALL INTESTINE

By Thomas G. Orr, M.D.

of Kansas City, Kansas

from the university of kansas school of medicine

In the investigation of the rôle played by sodium chloride in the body, the work of Hughson and Scarff[1] will always stand out as an initial stimulus for such experimentation. In 1924 these authors noted that the intravenous injection of hypertonic sodium-chloride solution would cause active peristalsis and suggested that post-operative distention, a mild form of ileus, might very well be avoided by the use of sodium-chloride solution. They report two cases of adynamic ileus successfully treated with salt after the failure of pituitrin, stupes and oral and rectal medication. Dreyer and Tsung[2] have also noted in experimental animals that hypertonic solutions of sodium chloride cause an increase in intestinal movements. No effect was noted by these observers when an isotonic solution was used. A number of French authors ([3 to 12]) have used hypertonic salt solution as a therapeutic agent in the various types of ileus. Their published reports are all favorable. Patry,[13] Battista,[14] Ross,[15] and Coleman[16] also record good results in clinical cases. The solution has been used in all cases to stimulate peristalsis.
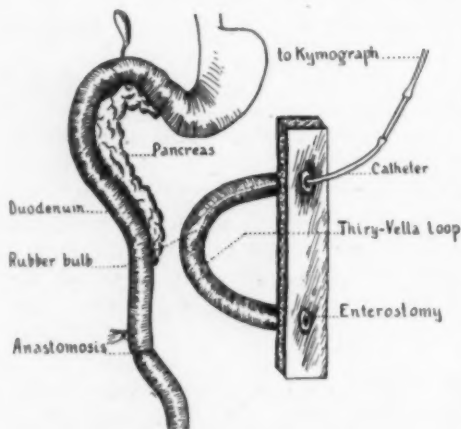


Fig. 1.—Thiry-Vella loop of upper jejunum.

In recent years the importance of sodium chloride in the treatment of intestinal obstruction and peritonitis has been frequently emphasized. One of the most interesting observations has been the relationship of salt to the chemical changes occurring in the blood, incident to obstruction of the small bowel. The rise in non-protein nitrogen and carbon dioxide combining power, and the fall of the chlorides as a result of high intestinal obstruction can be experimentally prevented and controlled by the administration of sodium-chloride solution. Since distilled water, glucose solutions, sodium bicarbonate and other salts have no such action, it is concluded that sodium chloride plays a specific rôle in maintaining the water distribution and balance in the body as well as being an important factor in stabilizing the chemical balance. Hughson and Scarff have made the interesting observation that an intravenous injection of hypertonic salt solution decreases the ab-
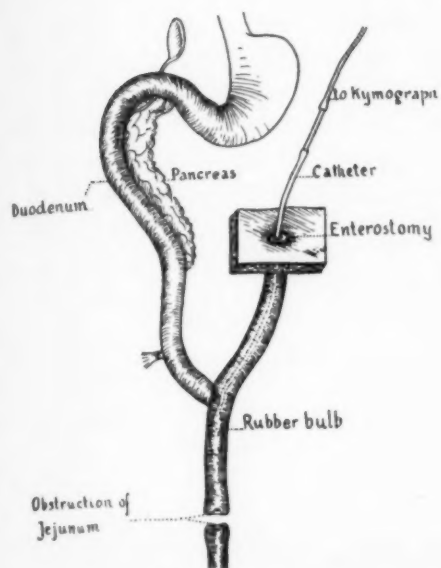
FIG. 2.—Jejunal fistula with obstruction of upper jejunum.
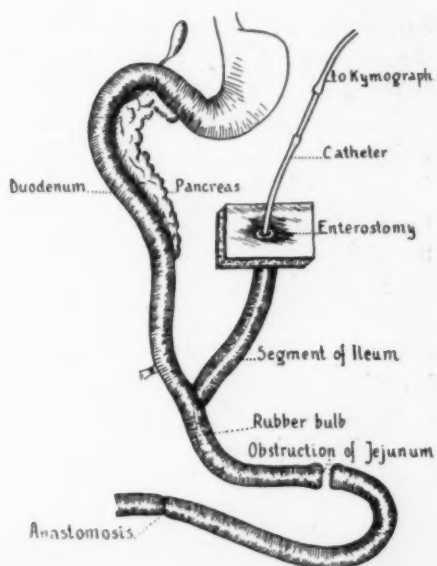


FIG. 3.—Jejunal fistula with obstruction of upper jejunum. Segment of lower ileum used to produce fistula.
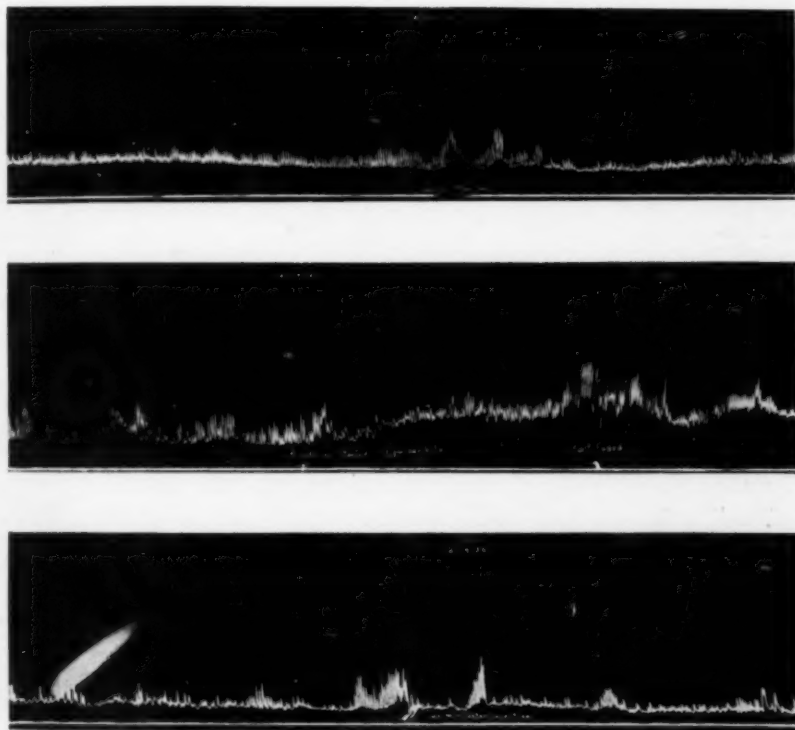






FIG. 4.—Thiry-Vella loop. Intravenous injection of 10 per cent. sodium-chloride solution, one gram of salt per kilo of body weight.

733

sorption rate of water from an isolated loop of intestine. Experimental evidence presented by Carlson and Wangensteen,[17] Ochsner, Gage and Cutting[18] and others conclusively prove that the administration of hypertonic sodium-chloride solution stimulates both the intestinal tone and peristalsis. Lehman and Gibson[19] have noted that a 2 per cent. solution of sodium chloride introduced into the stomach will stimulate forward peristalsis and relieve nausea and vomiting. It is probable that the sodium chloride acts directly upon the muscle of the bowel.

In a series of experiments on dogs we have tested the action of sodium chloride both before and after obstruction of the small bowel. In the first series a Thiry-Vella loop (Fig. 1) was made and tracings of the normal intestine taken on kymograph records after administering intravenously salt and glucose solutions of varying concentration.[20] In the second series, a preliminary jejunostomy was done by two different methods. The first method used was a simple section of the jejunum about 12 to 18 inches below
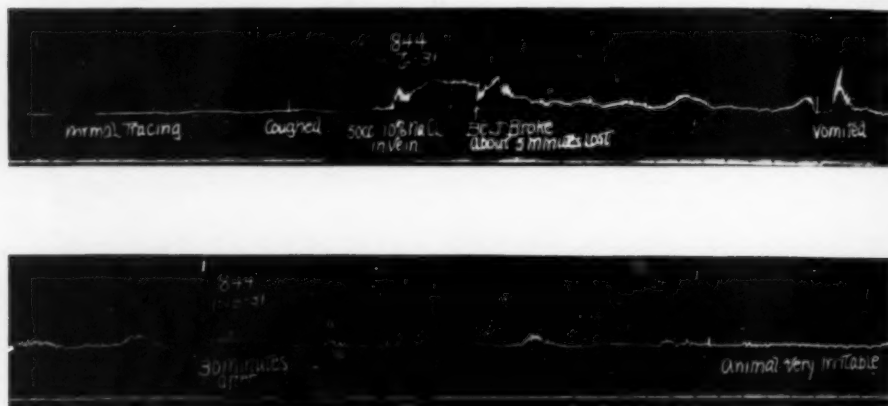


FIG. 5.—Kymographic tracing of upper jejunum forty-eight hours after obstruction.

the ligament of Treitz with an end-to-side anastomosis between the proximal segment and the jejunum below the site of section and a fixation of the cut end of the distal segment beneath the skin. After the wound was soundly healed the abdomen was reopened, the bowel obstructed about 12 to 18 inches below the anastomosis and the end beneath the skin opened, producing a jejunal fistula. (Fig. 2.) The second method was that suggested by Mann and Bollman[21] and Scott and Ivy[22] in which a segment of the lower ileum was transplanted between the upper jejunum and the skin of the upper abdominal wall to produce a jejunal fistula. (Fig. 3.) We prefer the latter method since there is less leakage of upper intestinal juices which endangers the life of the animal.[23] At the operation for obstruction of the jejunum, a rubber bulb with catheter attached was placed in the obstructed portion of the gut while the abdomen was opened. In some cases a slight constriction of the bowel was made with a ligature proximal to the bulb to prevent its regurgitation. In almost every experiment a hypertonic

solution of sodium chloride injected intravenously produced an increase in the gut tone and stimulated peristalsis of the jejunum. (Figs. 4, 5, 6 and 7.) With the use of physiologic saline solution we have not been able to record any definite change in the gut activity as did Hughson and Scarff.
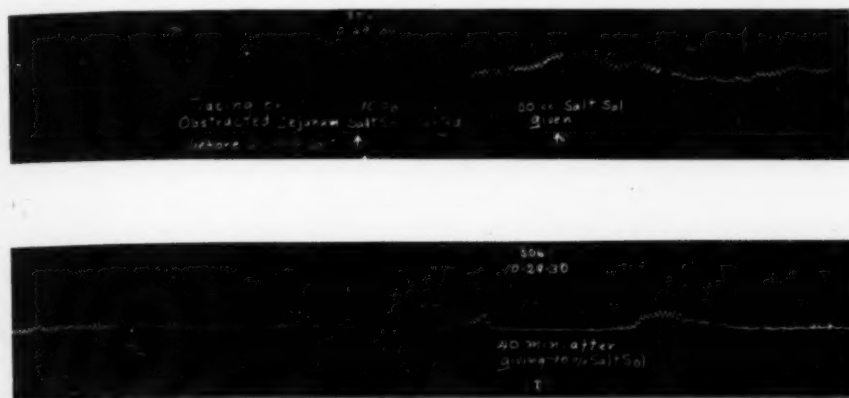


FIG. 6.—Tracing of upper jejunum forty-eight hours after obstruction eighteen inches below the ligament of Treitz.

Glucose has no noticeable effect on the bowel when injected intravenously. Hypertonic salt solutions injected directly into the lumen of the bowel through the fistula cause active contraction of the gut with often vomiting and defecation within a few minutes. In those animals having obstruction of the



FIG. 7.—Tracing of upper jejunum ninety-six hours after obstruction. Repeated small doses of hypertonic sodium chloride.

jejunum it was usually noted that the rhythmic contractions of the bowel were diminished and not infrequently there was some delay in the response to hypertonic salt solutions.

Our results in the treatment of post-operative "gas pains" have been

quite striking.[24] A high percentage of patients having abdominal pain associated with moderate distention respond to the intravenous injection of 20 cubic centimetres of a 10 per cent. sodium-chloride solution with the passage of flatus and relief from pain. It is frequently necessary to repeat this dose from one to three times. In the more seriously ill patients with impending paralytic ileus or intestinal obstruction, 500 cubic centimetres of a 5 per cent. solution is usually used as an initial dose if the blood chlorides are much below normal. The importance of giving hypertonic solutions very slowly must be realized. In the Kansas University Hospital we have adopted the rule that 20 cubic centimetres of a 10 per cent. solution must be given over a period of five minutes and 500 cubic centimetres of a 5 per cent. solution must consume at least one hour. Given at these rates we have not had any bad results. A local thrombus will at times form in a vein, rendering it unfit for immediate future use.

In the treatment of patients having dehydration and hypochloræmia, it is essential to know that glucose is not a substitute for sodium chloride. Gamble and Ross[25] emphasize this point when they state that sodium chloride is the only one of a long list of salts containing both of the ions specifically required for plasma repair. It is, therefore, important to recognize the fact that a solution of sodium chloride acts as a specific in those patients having marked fluid and chloride loss.

### CONCLUSIONS

(1) Experimental studies and clinical observations indicate that sodium chloride in hypertonic solutions increases the tone of the small intestine and stimulates peristalsis.

(2) The intravenous administration of hypertonic sodium-chloride solution as a peristaltic stimulant is indicated in post-operative distention with "gas pains," paralytic ileus, and as an adjunct to the treatment of intestinal obstruction after the obstruction has been relieved either by direct attack or by enterostomy.

(3) The administration of sodium-chloride solution in proper concentration is considered a specific treatment for the dehydration and hypochloræm a incident to the various types of ileus.

### REFERENCES

[1] Hughson, W., and Scarff, J. E.: Bull., Johns Hopkins Hosp., vol. xxxv, p. 197, July, 1924.

[2] Dreyer, N. B., and Tsung, T.: J. Pharmacol. and Exper. Therap., vol. xxxvi, p. 629, August, 1929.

[3] Clement, F.: Bull. et mem. Soc. de chir. de Par., vol. xxii, p. 347, May 16, 1930.

[4] Bojovitch, V.: Presse med., vol. xxxviii, p. 1662, December 6, 1930.

[5] Courty, L.: Bull. et mem. Soc. nat. de chir., ol. liv, p. 1450, December 22, 1928; vol. lv, p. 602, May 4, 1929.

[6] Lion, R.: Bull. et mem. Soc. de chir. de Par., vol. xx, p. 141, February 17, 1928.

[7] Kuss, G.: Bull. et mem. Soc. nat. de chir., vol. liv, p. 1460, December 29, 1928; vol. lv, p. 95, February 2, 1929.

[8] Denis, R.: Presse med., vol. xxxviii, p. 203, February 8, 1930; vol. xxxviii, p. 906, July 7, 1930.

[9] Gosset, A. Binet, L., and Petit-Dutaillis, D.: Presse med., vol. xxxvi, p. 17, January 7, 1928.

[10] Dogliotti, A. M., and Mariano, M.: Presse med., vol. xxxviii, p. 880, June 28, 1930.

[11] Barthelemy: Bull. et mem. Soc. nat. de chir., vol. lvi, p. 637, May, 1930.

[12] Bouisset, L., and Fabre, P.: Compt. rend. Soc. de biol., vol. civ, p. 847, July 4, 1930.

[13] Patry, R.: Schweiz. med. Wchnschr., vol. lx, p. 692, July 19, 1930.

[14] Battista, A.: Riforma med., vol. xlv, p. 905, July 6, 1929.

[15] Ross, J. W.: Canad. M. A. J., vol xvi, p. 210, October, 1927.

[16] Coleman, E. P.: Anæsth. and Analg., vol. vi, p. 210, October, 1927.

[17] Carlson, H. A., and Wangensteen, O. H.: Proc. Soc. Exper. Biol. and Med., vol. xxvii, p. 676, 1930.

[18] Ochsner, A., Gage, I. M., and Cutting, R. A.: Arch. Surg., vol. xxi, p. 924, December, 1930.

[19] Lehman, E. P., and Gibson, H. V.: J. A. M. A., vol. lxxxiv, p. 1259, April 25, 1925.

[20] Orr, T. G., Johnstone, P. N., and Haden, R. L.: Surg. Gynec. and Obst., vol. lii, p. 941, May, 1931.

[21] Mann, F. C., and Bollman, J. L.: ANNALS OF SURGERY, vol. lxxxiii, p. 794, March, 1931.

[22] Scott, H. G., and Ivy, A. C.: ANNALS OF SURGERY, vol. xciii, p. 1197, June, 1931.

[23] Orr, T. G., and Haden, R. L.: J. Exper. Med., vol. xliv, p. 795, December, 1926.

[24] Orr, T. G.: ANNALS OF SURGERY, vol. xliv, p. 144, July, 1931.

[25] Gamble, J. L., and Ross, S. G.: J. Clin. Investigation, vol. i, p. 403, June, 1925.

# SPINAL ANÆSTHESIA

By George P. Muller, M.D. and Richard H. Overholt, M.D.

of Philadelphia, Pa.

from the surgical division (service b) of the hospital of the university of pennsylvania

This paper is concerned with a clinical analysis of spinal anæsthesia and with the status of our present attitude toward its usefulness. Countless articles on the subject indicate the general acceptance of this form of anæsthesia. Emphasis has been placed upon the desirable features and upon the technic of administration under such titles as "Controllable Spinal anæsthesia" and "The Safe Spinal Anæsthetic." A smoother convalescence and an absence of pulmonary complications were promised. We have been urged to use spinal anæsthesia in preference to a general anæsthesia in the poor risk case. Some advocate the adoption of this form of anæsthesia for every major procedure, irrespective of age, location of the operative area, or general status of the patient. There is a paucity, however, of clinical reports which include failures, fatalities and immediate or remote untoward effects. There has been a reversal in our opinion about certain features of spinal anæsthesia. Because of the well-recognized advantages from the standpoint of the surgeon, spinal anæsthesia will continue to be the anæsthesia of choice in a large proportion of cases. We are coming, however, to regard it as an anæsthetic of less potential safety and therefore not as applicable to the poor risk case as was first thought.

When the use of spinal anæsthesia was first revived three years ago on the Surgical Division B. of the Hospital of the University of Pennsylvania, special charts for detailed notations about these cases were provided. Up to the present time 533 cases have been given a spinal anæsthetic and 78 per cent. of these have been seen in the follow-up clinic or communicated with by letter.

The proprietary preparation known as "Spinocaine"[1] a novocaine, alcohol, starch solution, was used in the first 114 cases. Among this series there were nine failures of the drug to produce anæsthesia. We were very much concerned about the lives of two patients because of the development of a sterile meningitis. One patient lost control of the urinary bladder for three months. In this group of 114 cases there was one table death. The follow-up reports show, that in this early series only one had any untoward symptom later which might be attributable to the anæsthetic. After twenty-two months this patient still complained of paresthesias in the lower extremities. Neurologic examination was not significant.

We next changed to the use of Neocaine, a French preparation similar in formula and toxicity to Novocaine. The crystals readily dissolve in the spinal fluid. In this way fresh solutions are certain and no foreign material

other than the anæsthetic agent is introduced within the subarachnoid space. Minor changes in technic have been made from time to time. The following procedure has proven to be the most satisfactory. Ephedrine sulphate, 50 or 100 milligrams is given intramuscularly, thirty minutes before the administration of the spinal anæsthetic. The lumbar puncture is made with the patient on the side in the horizontal position. The most convenient lumbar intervertebral space is used in all cases. From 3 to 6 cubic centimetres of spinal fluid is withdrawn, the Neocaine crystals dissolved in it, and the solution slowly reinjected. Barbatage is not done. We have felt that the agitation of the spinal fluid by the plunger of the syringe is not a constant way to control the height of the anæsthesia. The patient is returned to the dorsal position and kept in the horizontal plane. A period of five to eight minutes is given for anæsthesia to appear. In most cases anæsthesia of the entire abdomen will be obtained with as small a dose as 150 milligrams of the drug. Should the anæsthesia not be high enough, the head of the patient is lowered and kept in that position only until the desired anæsthetic height is obtained. To keep the patient in the Trendelenburg position early invites a high anæsthesia with its added risk. The height of the anæsthesia, in our hands, has been more satisfactorily controlled by varying the position of the patient, rather than the site of the injection, the force of the injection or volume of fluid injected.

Should a significant drop in blood-pressure occur, the patient is put in the Trendelenburg position at once. Inhalations of carbon dioxide may cause a rise in the blood-pressure. Adrenalin has been the most effective drug to combat the acute hypotension associated with spinal anæsthesia, although at times no drug whatever seems to be of any value. We have not been impressed with the benefits derived from the use of vasopressin, caffeine, or strychnine. Chen and Schmidt[2] have shown that small doses of ephedrine might cause cardiac failure when injected after a prolonged period of low blood-pressure. They say "apparently a heart depressed by continued low blood-pressure, with consequent inadequate coronary flow, is more sensitive to the depressant action of ephedrine, and less responsive to its stimulant effect, than the normal heart." Should the blood-pressure fall to 50 millimetres mercury or below without a recovery in four or five minutes, an intravenous infusion of 5 per cent. glucose is started.

The proximity that any single anæsthetic comes to the ideal can only be judged by an analysis in an unbiased way of the results in a large series of accurately recorded cases. We have found spinal anæsthesia completely satisfactory in 85 per cent. of the cases. In 7.7 per cent. it was necessary to give a general anæsthetic to complete the operation. One hour seems to be the average duration. The supplementing of a general anæsthesia, at the beginning of the operation, was required in 3.7 per cent. of the cases. No anæsthesia or an inadequate height was obtained in nineteen instances, an incidence of 3.6 per cent. Most of the failures occurred when the site of

the operation was to be in the upper abdomen although on three occasions the operative site was the inguinal region. (See Table I.)

TABLE I

*The Success of Spinal Anæsthesia*

|  | Cases | Per cent. |
|---|---|---|
| Total Number of Cases | 533 | |
| Entirely Satisfactory | 453 | 85 |
| Partially Satisfactory | | |
|    General Anæsthesia to finish | 41 | 7.7 |
|    General Anæsthesia supplemented | 20 | 3.7 |
| Complete Failures | 19 | 3.6 |
|    Spinocaine | 9 | 7.9 |
|    Neocaine | 10 | 2.4 |

The most disturbing and serious factor associated with spinal anæsthesia is the possibility of a marked fall in blood-pressure. A primary, then a secondary decrease in the blood-pressure may occur. The first or early blood-
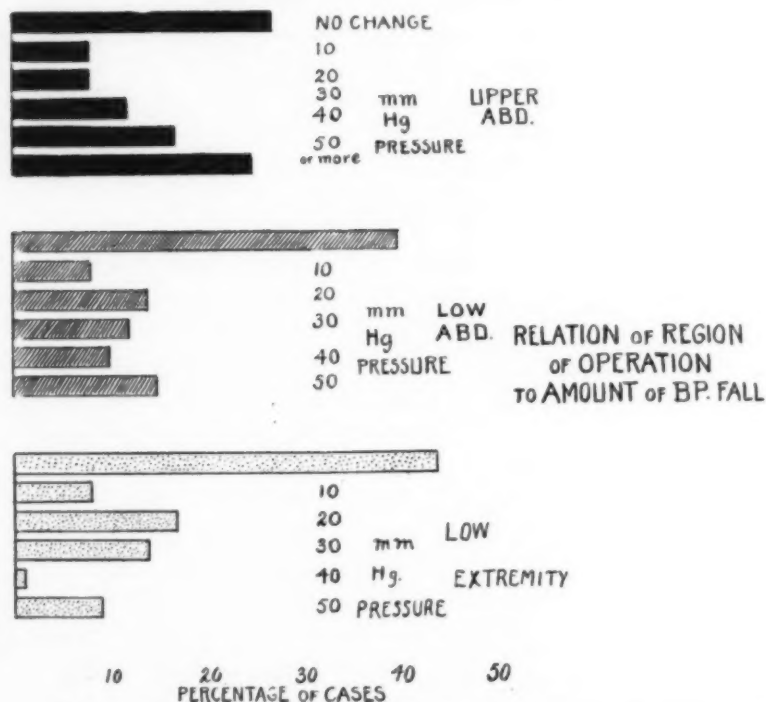


Fig. 1.—Graph showing the relation between the region of the operation and amount of the blood-pressure fall. The length of the columns indicates the percentage of cases in each group. The first column in each group represents the percentage of cases in which no change in the blood-pressure occurred during the period of anæsthesia. Between 30 and 40 per cent. showed no change on matter where the operation was performed. It is interesting to note that 9 per cent. of the patients who had an operation on a lower extremity were subjected to a blood-pressure fall of 50 millimetres of mercury or more.

pressure change comes in the first twenty minutes and is dependent upon the action of the drug itself. The delayed or secondary fall is the resultant

of a combination of factors, operative shock, loss of blood, a failing myocardium due to deficient coronary circulation and oxygen want or to a failure in adjustment of the vasomotor mechanism. The degree of the initial fall in blood-pressure must be dependent upon the percentage of the sympathetic fibres involved by the drug. The higher the sensory anæsthesia, as a rule, the lower the blood-pressure. With either Spinocaine or Neocaine and with the application of all of the well-accepted methods to prevent a decrease in blood-pressure, we have experienced a fall in about 60 per cent. of the patients. The site of the operation has not materially affected the degree of the blood-pressure fall or the time that the maximum fall occurred. (See Figs. 1 and 2.)

Surprisingly enough, the dosage of the drug has also had little effect upon the degree of the blood-pressure depression or upon the time that the maximum fall took place. A dose as low as 100 milligrams may be attended with a marked and alarming blood-pressure change. (See Figs. 3 and 4.) It has been interesting to find that about 50 per cent. of the cases leave the operating room with a lower blood-pressure than when the operation was started. This ratio is about the same, irrespective of the dose of the drug or the region of the operation. (See Table II.) We take issue with Koster[3] and others who consider lightly the hypotension associated with spinal anæsthesia. An immediate rapid fall is a sure sign that the anæsthetic agent has ascended to a high level. Following sensory anæsthesia and blockage of the autonomic nervous system, there is an ascending motor paralysis of the muscle of respiration. Until more is understood about the mechanism of the spinal anæsthetic deaths, the presence of a paralyzing drug in the upper spinal canal is to be considered a potentially dangerous state of affairs.

TABLE II

*Blood-pressure at Close of Operation*
Relation of Region of Operation and Dosage

|  | Blood-pressure Lower (Per cent.) | Blood-pressure Normal (Per cent.) |
|---|---|---|
| Operation in upper abdomen | 57 | 43 |
| Operation in lower abdomen | 43 | 57 |
| Operation in lower extremities | 40 | 60 |
| Dosage 100 milligrams (Neocaine) | 55 | 45 |
| Dosage 150 milligrams | 47 | 53 |
| Dosage 200 milligrams | 57 | 43 |
| Dosage 250 milligrams | 47 | 53 |

This table shows the per cent. of the patients who left the operating room with a blood-pressure lower than the normal pre-operative pressure for each respective case. Unless the final blood-pressure record had declined more than 10 millimetres mercury pressure it was included in the normal or no change group.

From the standpoint of patients who have a lack in vasomotor tone, a drop of 50 or more millimetres mercury pressure throughout the period of

the operation may leave the blood-pressure at an unrecoverable level. In eight cases, which died of shock a few hours after operation, the blood-pressure never was brought back from the low level induced by spinal anæsthesia. It is probable that the temporary spinal paralysis was a contributing factor in the initiation of the state of shock. Other conditions were present in all cases and the evaluation of the relative importance of the various contributing factors in each particular case is difficult. A brief résumé of three such cases follow:
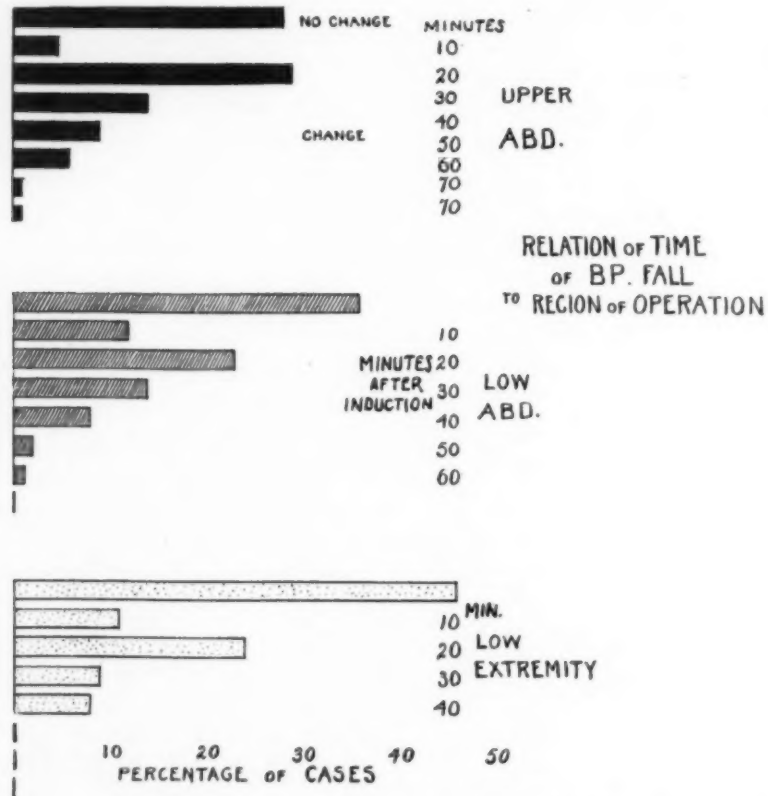


FIG. 2.—Graph showing the relation between the region of the operation and the time that the maximum decline in blood-pressure took place. Note that in all of the groups the maximum fall in most patients, if one occurred, was twenty minutes after the induction of the anæsthesia. In the upper abdominal group a small per cent. of the patients experienced the greatest fall in the blood-pressure as late as fifty or sixty minutes after induction. These late falls in blood-pressure represent the influence of associated factors incident to the operation or to the patient's disease.

CASE I.—Mrs. R. M., aged fifty-eight. Gall-bladder disease, jaundiced four weeks. In hospital eight days for observation and pre-operative preparation. Blood-pressure 160/75, temperature, pulse, respiration normal. Ephedrine 100 milligrams given intramuscularly followed by spinocaine 3.5 cubic centimetres intraspinally. Cholecystectomy and choledochotomy done. Liver showed a moderate cirrhosis. Duration of operation sixty minutes. Steady decline in blood-pressure to 110/70 during first thirty minutes. Blood-pressure on return to ward 100/60. Patient died thirteen hours after operation after being in extreme shock for one hour. Autopsy failed to explain cause of death. A small amount of blood was found in the right sub-diaphragmatic space.

CASE II.—Mrs. I. T., aged thirty-seven. This patient had been operated upon for gall-bladder disease a year previously (elsewhere). A biliary cyst developed in the upper abdomen, was operated nine months later and adhesions prevented the identification of structures in the biliary area. Jaundice persisted. Patient was readmitted three months later and prepared for operation again. Blood-pressure 120/74, temperature 99.6, pulse 86, respiration 20. Given ephedrine 100 milligrams intramuscularly followed by 200 milligrams neocaine. A choledochoduodenostomy was done. Duration of operation sixty-five minutes. The blood-pressure fell to 90/60 during the last third of the operation but came back to nearly normal when taken from the table. Upon
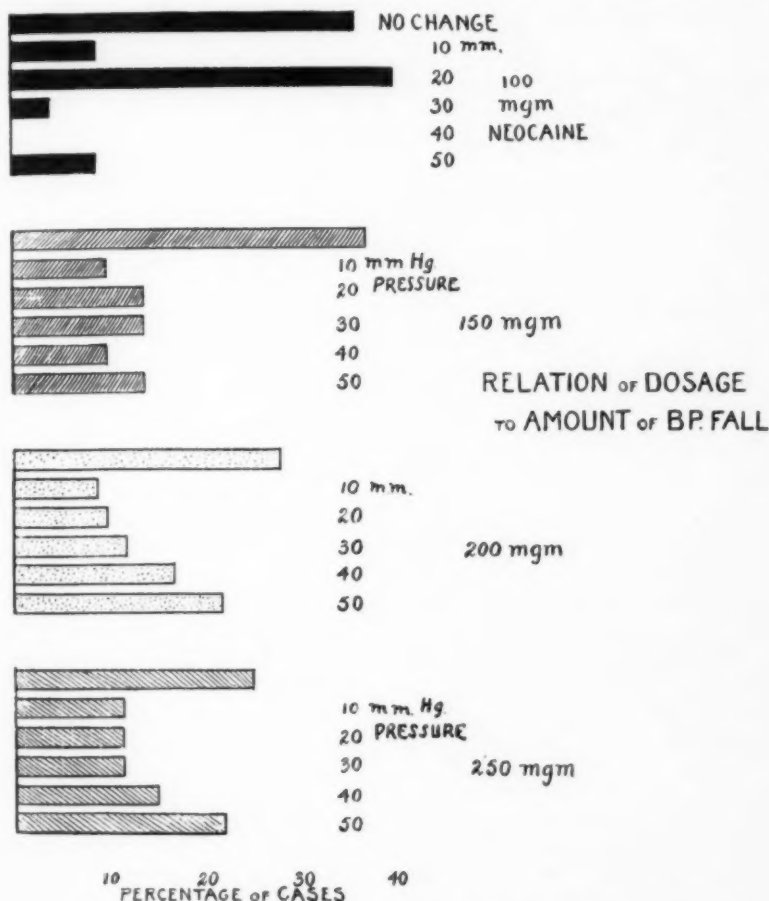


FIG. 3.—Graph showing the relation between the dosage of the drug used and the amount of the blood-pressure fall. Note that there is a slightly greater percentage of cases that showed a marked fall in blood-pressure when the larger doses of the drug were used. However, the use of 50 or 100 milligrams may be attended with a marked change in the blood-pressure.

return to the ward the blood-pressure was 76/58 and did not go above that point. Hæmorrhage did not occur. Intravenous glucose was administered. The patient died eight hours after operation. An explanation for death is wanting. An autopsy was not permitted.

CASE III.—Miss E. T., aged thirty-six. Was originally operated for carcinoma of the ovary two and one-half years previously. Was re-operated on three occasions since (elsewhere). Had persistent tachycardia around 120 during period of observa-

tion. There was evidence of renal damage. Blood-pressure 180/110. Was given ephedrine, 50 milligrams and neocaine, 200 milligrams. Exploratory laparotomy for intestinal obstruction, subacute, and excision of metastatic lesion and lateral ileoileal anastomosis. Operating time, seventy minutes. Blood-pressure fell 70/40 during most of the operation and toward the end was brought up to 110/80 following intravenous 5 per cent. glucose. After return to room, blood-pressure never exceeded 130 systolic. Death in thirty-one hours. Uræmia acidosis or hæmorrhage was not in evidence. At autopsy a left hydronephosis and an early simple nephrosis on the right was found.

Rapoport,[4] Arnheim and Mage,[5] McKittrick, McClure and Sweet[6] and Falk[7] have reported early post-operative deaths in which the spinal anæsthetic was held partly responsible. It is our practice now not to give a spinal anæsthetic to any patient who before operation or who may during or after the operation, possess other conditions which tend to produce a low blood-pressure. Burch, Harrison and Blalock,[8] have shown that animals under spinal anæsthesia do not stand hæmorrhage as well as those under general anæsthesia. Our clinical experience supports their observation and further shows that other shock-producing agencies are not well tolerated. The preliminary rise in blood-pressure that follows the use of ephedrine given thirty minutes prior to the spinal anæsthetic has served as a good index of the flexibility or reserve of the vasomotor mechanism. Those cases which failed to show a rise with ephedrine were more likely to be depressed by the spinal anæsthetic.

In this series there were two spinal anæsthetic deaths, a mortality of 0.37 per cent.

CASE I.—Mr. J. S., aged sixty-nine. Symptoms and signs of intestinal obstruction of five days' duration. Critically ill, flushed, distended and tense abdomen. Had hemiplegia for four years. Blood-pressure 124/90, temperature, pulse, respiration 100°–98–24. Intravenous saline, 1,000 cubic centimetres was given immediately and operation prepared. Spinal tap dry. Three cubic centimetres spinocaine was injected into what was thought to be the spinal canal. Anæsthesia was secured to the level of the fifth thoracic segment. The blood-pressure immediately fell to 65/0. Upon exploration of the abdomen a general peritonitis was found. There was a volvulus involving the terminal ileum and a second point of obstruction in the small bowel produced by adhesions to the hepatic flexure. At the conclusion of the operation there was a sudden cessation of respiration and of cardiac action simultaneously forty minutes after the anæsthetic was given. Artificial respiration, stimulants and an intravenous infusion were administered. The time of death, after forty minutes, would indicate that it was not primarily due to respiratory paralysis. The prolonged hypotension, the result of a combination of factors, with the associated oxygen lack in all the tissues, including the medulla and heart is the most probable explanation for the death in this case. Although this form of anæsthesia provided the most satisfactory relaxation for exploration of the abdomen, it was a mistake to administer it in the presence of other shock-producing factors.

The second spinal death occurred late in our series when errors in technic or management were less likely and in a patient whose general condition was considered good.

CASE II.—Mrs. A. H., aged fifty-six. This patient had had symptoms for one year, principally pain in the left lower quadrant of the abdomen. Bed-ridden for four weeks. Ascites and a mass in the lower abdomen were found. General condition good.

Blood-pressure 160/80, temperature, pulse, respiration 99°–92–22. Two hundred and fifty milligrams of neocaine was given intraspinally. The solution was made up with 4 cubic centimetres spinal fluid. Barbatage was not done. Anæsthesia extended to the third thoracic segment and the operation was begun. There was a steady decline in blood-pressure and there was a simultaneous cessation of the heart and respiration twelve minutes after the induction of the anæsthesia. The course of events, in this case, took place so rapidly that it is difficult to say what was the mechanism. At the
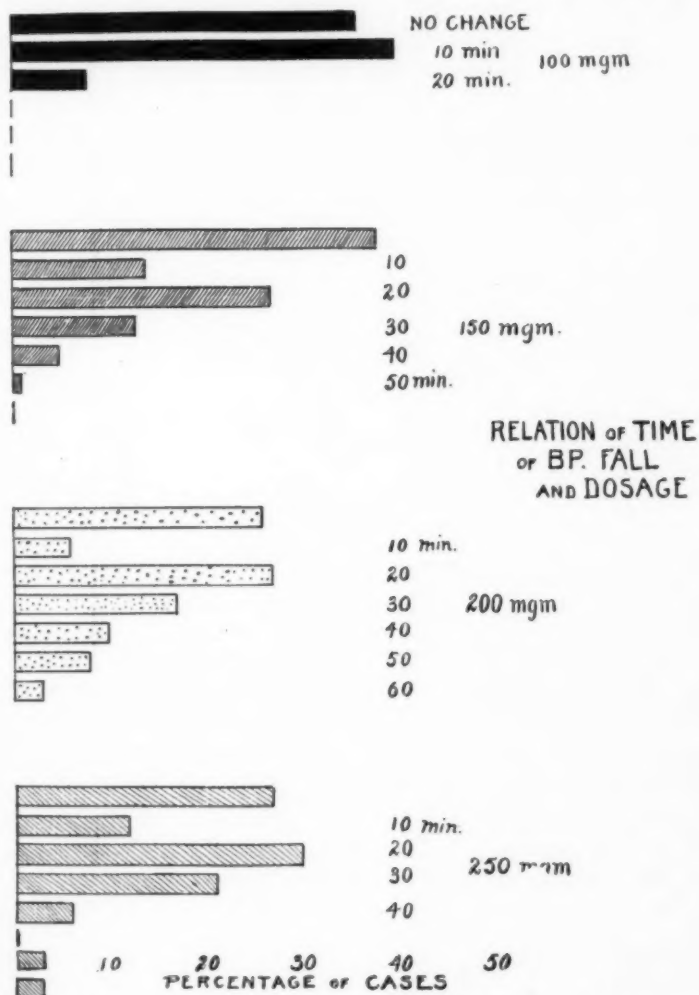


FIG. 4.—Graph showing the relation between the dosage of the drug and the time that the blood-pressure showed its maximum change. It will be noted that the higher doses are attended with a larger percentage of cases showing the late blood-pressure fall.

time the blood-pressure was falling due to the anæsthetic, the abdomen was being opened and a large twisted ovarian cyst was being delivered. Phrenic paralysis, medullary anæmia, or cardiac dilatation singly or in combination, might have taken place.

In addition to acute hypotension or death, other less serious untoward effects of spinal anæsthesia have been noted. (See Table III.) Nausea was

present in 31 per cent. of the cases and vomiting in 14 per cent. The frequency was greater if the operation was carried out in the upper abdomen. The anæsthetists were concerned about the respiratory activity or the patients complained of difficulty in breathing in 6 per cent. of the cases. In two cases in which spinal anæsthesia was given for short lower abdominal operations, the patients went into a latent or secondary shock two and one-half and five hours after operation. There was a sudden fall in blood-pressure, difficulty in breathing, rigid abdomen and a disorganized type of upper costal activity without any evidence of diaphragmatic movement. It was thought that much of the peculiar course of events in these cases was due to the sudden appearance of pain.

## TABLE III

### Immediate Untoward Effects
(Percentages)

|  | Region of Operation | | |
|---|---|---|---|
|  | Upper Abdomen | Lower Abdomen | Perineal or Lower Exterior |
| Nausea | 41 | 31 | 6 |
| Vomiting | 25 | 9 | 5 |
| Respiratory Difficulties | 8 | 6.5 | 1.6 |
| Extreme Pallor | 7 | 7.6 | 0 |
| Cyanosis | 2.2 | 0 | 1.6 |
| Sweating | 0.5 | 2.4 | 0 |
| Shoulder Pain | 4 | 2 | 0 |
| Generalized Pruritus | 6 | 1.3 | 0 |
| Death During Anæsthesia (Two Cases) | 0 | 0.7 | 0 |
| Death During Anæsthesia, percentage of all cases |  |  | 0.38 |

Untoward effects of spinal anæsthesia as encountered in the convalescent patient are relatively unimportant. (See Table IV.) Only 4 per cent. complained of a transient headache and an equal small number had temporary urinary retention. Almost all of the patients who had difficulty in voiding had had inguinal or perineal operations. The incidence of such difficulties is as high with general anæsthesia. Two patients who developed signs and symptoms of meningitis, proved to have cloudy but sterile spinal fluid and both recovered. There were no residual effects in either case.

## TABLE IV

### Remote Untoward Effects of Spinal Anæsthesia

533 Cases                           78 per cent. follow-up

|  | Cases | Per Cent. |
|---|---|---|
| Headache | 21 | 4 |
| Voiding difficulties (Upper abdomen, 2; Lower abdomen, 17) | 20 | 3.7 |
| Persisting hypotension | 8 | 1.5 |
| Latent shock with return of sensation | 2 | 0.4 |
| Meningismus | 2 | 0.4 |
| Paresthesias lower extremity for two years | 1 | 0.2 |
| Tinnitus | 1 | 0.2 |
| Paralysis, any muscle group | 0 | 0 |

Pulmonary complications have been just as frequent, perhaps more so, than when a general anæsthesia is used. (See Table V.) These figures coincide well with the findings of McKittrick, McClure and Sweet[6] who compared two surgical services at the Massachusetts General Hospital where spinal anæsthesia predominated in one and general anæsthesia in the other. There was a slightly higher incidence in the spinal group. During the past two years two patients have died as a result of bilateral lower lobe atelectasis. Autopsies were secured on both cases. We have never had such an experience with general anæsthesia. The slow, shallow type of breathing, the extreme relaxation of the abdominal and intercostal muscles and possibly a relaxation of the diaphragm because of sympathetic paralysis are possible explanations for the high incidence of such complications. All of these factors predispose to post-operative pulmonary hypoventilation as has been shown by Muller, Overholt and Pendergrass.[9]

TABLE V

*Pulmonary Complications and Anæsthesia*

| Type Operation | Spinal Anæs. Per cent. Pul. Complications | Deaths Per cent. | General Anæs. Per cent. Pul. Complications | Deaths Per cent. |
|---|---|---|---|---|
| Gall-bladder | 4.8 | 0 | 0 | 0 |
| Gastric* | 6.2 | 6.2 | 10. | 6.2 |
| Appendix | 0 | 0 | 3 | 0 |
| Hernia | 2.3 | 0 | 0 | 0 |

*Includes two cases of bilateral (lower lobes) massive atelectasis proven at autopsy.

Seventy-eight per cent. of this series of cases were seen in the follow-up clinic or communicated with by letter. Only two patients complained of any symptoms which might have been late spinal anæsthesia effects. One complained of paresthesia of the inner side of the thighs since and for twenty-two months after a spinal anæsthetic. The neurologic examination of this patient was negative. Another patient complained of a tinnitus of moderate severity which was present since the induction of the anæsthesia.

### CONCLUSIONS

(1) Spinal anæsthesia carries with it a higher table mortality than other forms of anæsthesia in our hands. Its many advantages often outweigh the added risk that it carries and for that reason spinal anæsthesia has become a valuable adjunct to our present-day anæsthetic methods.

(2) Hypertension, hypotension or any condition which will in itself produce a hypotension during the course of the operation, constitutes a contra-indication to the use of spinal anæsthesia.

(3) Open drop ether in the poor risk patient is the safest anæsthetic. Spinal anæsthesia is reserved for the good risk patient where the added dangers of the anæsthesia can be assumed in order to facilitate the technical operative procedure.

747

(4) Sudden deaths after operation should be charged up partially against spinal anæsthesia when the hypotension induced by this form of anæsthesia persists.

(5) The site of the operation or the dose of the drug has a surprisingly small influence upon the degree of the fall in blood-pressure or in the time at which the maximum fall takes place.

(6) The incidence of pulmonary complications is not reduced by spinal anæsthesia.

DISCUSSION.—DR. ALEXANDER PRIMROSE (Toronto, Canada) said, in connection with spinal anæsthesia, from the standpoint of the general surgeon, he was not prepared to discuss the details of the technic of spinal anæsthesia, or the value of the different forms of technic, but he did know that in abdominal operations it makes the work of the surgeon infinitely easier. He would like to put it this way: If there are harmful results from spinal anæsthesia, if certain results are attributed to spinal anæsthesia—he was inclined to believed that one minimizes the amount of trauma to the viscera under spinal anæsthesia and he believed that one can lower the mortality very much by handling the viscera delicately and gently—spinal anæsthesia prompts the surgeon to handle the viscera with the minimum amount of trauma.

As to the danger of the use of spinal anæsthesia in surgery above the diaphragm, he recalled that one of his colleagues in Toronto, Doctor Shenstone's work has, at the present time, to his record eleven cases of lobectomy in which he has removed one lobe of the lung, and in some cases one lobe and part of another lobe. In these eleven cases he has had two deaths. The last six cases have been done under spinal anæsthesia. He is firmly convinced that the conditions under spinal anæsthesia are most favorable to a successful result in these cases.

DR. HAROLD L. FOSS (Danville, Pennsylvania) said that in a paper on the question of anæsthetics presented in Philadelphia a few weeks ago by a distinguished member of this Association, a man for whom we all have the highest regard, spinal anæsthesia is summarily discarded as are nearly all means of producing anæsthesia other than ethylene or ether or infiltration. This paper was not discussed. It will be read by thousands of physicians and surgeons in the country and its conclusions will be accepted by many, but he thought it should not go unchallenged.

He was greatly interested in determining if he were correct in his conclusions that spinal was proving, in his hands, a satisfactory and, what is even more important, a safe anæsthetic. In going over the records he discovered that his mortality, in general abdominal surgery, had dropped materially since he began, in certain cases, to use spinal anæsthesia in place of ether, a decrease that could be directly attributed to the change in anæsthetics. It was not only apparent in the general list but proved so in operations for specific conditions. In reviewing his first 200 consecutive cases of acute appendicitis performed under spinal and comparing them with the 200 preceding these and operated on under ether. Over 70 per cent. of these patients had peritonitis when they reached him and the operations were all performed by him, in the same hospital, with the same personnel, and the same pre-operative and post-operative care, everything being equal except in the first 200 cases ether was used, in the following 200, spinal. There was an immediate reduction in mortality from 7.4 per cent. to 4.2 per cent.

He then investigated his cases of acute perforating duodenal ulcer, his cases of acute intestinal obstruction and those of biliary tract disease. In all there was a definite, and he felt, significant decrease in mortality following his adoption of spinal in place of ether as an anæsthetic. Staff members are thoroughly convinced from the analysis of these results that the change in anæsthetics has, undoubtedly, brought about a definite reduction in mortality.

As to the question of the patients choosing the anæsthetic, the speaker never thought it necessary or even advisable and has always felt that it is better to educate his patients to be willing to leave such questions, as they do the question of operative technic, entirely to the best judgment of the surgeon in whom they should have complete confidence. He does not discuss the matter with his patients who have, however, in a vague way, an idea that he uses spinal anæsthesia and he has never had the slightest trouble in this respect in over 1,600 spinal anæsthesias. It may be of some interest in connection with this discussion to state that, in our own clinic, where spinal has been extensively used for the past two years, twenty-eight persons in our hospital staff have recently been operated upon and all selected spinal anæsthesia.

All of us realize that the method possesses certain dangers. No anæsthetic is devoid of them all. But it has tremendous advantages far outweighing its dangers which, in the long run, makes it a most desirable anæsthetic and one which, rather than increasing mortality, will, especially in certain bad risk cases where relaxation is desirable, as in acute appendicitis with peritonitis, intestinal resections in acute intestinal obstruction or in carcinoma of the colon, the closure of visceral perforations, etc., be the direct means of saving life.

Spinal anæsthesia has acquired unusual popularity in the past few years and, it is true, in a few hands has been badly used. Such a condition must be expected with all newly developed procedures in surgery, whatever they may be, yet it does not justify the unqualified condemnation of the method by those who have had no experience with it and those of us who have found spinal of tremendous aid should not be forced to discard it merely because of personal prejudices which have been engendered largely by reports of those who, because of inexperience with the technic, have had unsatisfactory results. His conviction is that spinal anæsthesia is one of the great contributions to surgery; that it is extraordinarily satisfactory in its present state; that, in the majority of general major surgical procedures performed below the level of the diaphragm it is the anæsthetic of choice; that, in all probability, from the laboratory of the biochemist will ultimately come newer drugs probably of a synthetic nature which, used intraspinously, will produce a most satisfactory anæsthesia without even the slight tendency to untoward results spinal may now possess but which, when compared with inhalation anæsthetics in general, especially ether, are practically negligible.

Dr. FRANCIS A. C. SCRIMGER (Montreal, Canada) said that he had been recently using spinal anæsthesia a good deal more than formerly. One point that comes out is that when one has realized that a patient can be held in a rather head down position, that has seemed important to us, and has avoided very largely the enormous drops in blood-pressure.

Possibly spinal anæsthesia as a term is not exactly accurate. It is very largely a root anæsthesia and for that reason a head down position is not objectionable. It is really not the spinal cord that is made anæsthetic but the roots of the nerves as they leave the spinal cord. For that reason it gives a greater degree of confidence and avoids a good many fears.

Dr. GEORGE P. MULLER (Philadelphia, Pennsylvania) rejoined that he had done two cases of thoracic surgery and five tumors of the breast, under spinal anæsthesia, but he did not think he would do it again. He believed that enough of them would raise the mortality, at least with the present drugs. He did not think spinal anæsthesia could reduce the mortality of acute appendicitis except insofar as here and there it makes a difficult operation a little easier. The mortality of appendicitis varies so with the kinds of cases one gets, the percentage of drainage cases, the time the doctors send them in, etc. In his last 200 cases his mortality is about 2 per cent. He does not claim any credit for that because he had a long run of easy cases. Our appendicitis cases, as a rule, are done under general anæsthesia because the operation can be done fast. He preferred not to anæsthetize a patient with something that was going to send him to a

ward anesthetized for an hour when he could do the appendectomy practically always in twelve to twenty minutes. So we use local anæsthesia and just enough gas to keep them quiet.

There were times when he did use a spinal. For perforated ulcers it is perfect. One gets rid of the rigidity, which is never touched by a general anæsthetic, and enables one to do better work.

Doctor Scrimger spoke of the head down position. If one uses the neocaine solution it has a tendency to run down. Since they changed to neocaine he finds it necessary to keep them flatter. And here also is where one is in between two difficult positions. If the patient has a tendency for the neocaine to work itself upward in spite of the flat position, in spite of a small dose, as it does in some patients, if one puts them in that head down position very often it drives the anæsthesia to a still higher point. So he tries to hold off just a little bit until the glucose solution gets started which tends to bring them up. Then, after twenty minutes' time or thereabouts, if necessary, if the hypotension is still prolonged, he holds them in a head down position.

## REFERENCES

[1] Pitkin, George P.: Controllable Spinal Anæsthesia. J. Med. Soc. N. J., 1927.

[2] Chen, K. K., and Schmidt, Carl F.: The Action and Clinical Use of Ephedrine. J. A. M. A., vol. lxxxvii, p. 836, September 11, 1926.

[3] Koster, Harry: Spinal Anæsthesia with Special Reference to its Use in Surgery of the Head, Neck and Thorax. Am. Jour. of Surg., vol. v, pp. 554–570, December, 1928.

[4] Rapoport, Boris: Observations on Spinal Anæsthesia with a Report of 1875 Cases. New Eng. Jour. Med., vol. cciv, pp. 1254–1259, June 11, 1931.

[5] Arnheim, R. E., and Mage, S.: Spinal Anæsthesia, on Analysis of 497 Cases. ANNALS OF SURGERY, vol. xciii, pp. 929–933, April, 1931.

[6] McKittrick, L. S., McClure, W. L., and Sweet, R. H.: Spinal Anæsthesia in Abdominal Surgery. S. G. and O., vol. lii, pp. 898–904, April, 1931.

[7] Falk, H. C.: Anæsthesia Deaths. Am. Jour. of Surg., vol. xi, p. 461, March, 1931.

[8] Burch, J. C., Harrison, T. R., and Blalock, Alfred: A Comparison of the Effects of Hæmorrhage under Ether Anæsthesia and under Spinal Anæsthesia. Arch. Surg., vol. xxi, pp. 693–697, October, 1930.

[9] Muller, George P., Overholt, R. H., and Pendergrass, E. P.: Post-operative Pulmonary Hypoventilation. Arch. Surg., vol. xix, pp. 1322–1341, Part Eleven, December, 1929.

# CLINICAL EXPERIENCES WITH GWATHMEY'S COLONIC OIL-ETHER ANÆSTHESIA

By Henry H. M. Lyle, M.D.,

James Taylor Gwathmey, M.D., and Leonid Watter, M.D.

of New York, N. Y.

Colonic anæsthesia was first administered by Gwathmey at the Stuyvesant Square Hospital (formerly the New York Skin and Cancer Hospital) in 1914. The Stuyvesant Square is a special hospital devoted to the treatment of skin and cancer. The cancer service is a separate entity and deals with all forms of cancer. The therapy has been chiefly surgical. The hospital tradition stands for the most thorough cancer surgery. The technic as used today has been built up by the labors of Willy Meyer, Foot, Eggers, Semkin, Torek, Kennedy, Morrow and others. The criterion for operation has been the extent of the cancer rather than the condition of the patient. We believe that the possibilities in safely prolonging the operation and the development of a meticulous cancer technic has been greatly enhanced by the employment of colonic ether. The direct result of all this being an improvement in the percentage of apparent cures.

In the administration of this anæsthesia two distinct processes take place. The first is the physical separation of the ether from the oil; the second, the physiologic absorption of the liberated ether vapor. The dissolution of the mixture in the colon is at a constant rate and the total vapor liberated is limited by the amount of ether used. From a mixture containing 6 ounces of ether, the ether is absorbed at the rate of 2 ounces per hour, this produces the required saturation of the blood for anæsthesia. The constant elmination by way of the lungs prevents the cumulative effect which may occur in the inhalation method. In this type of anæsthesia, the higher centres of thought, speech, *etc.*, are not so profoundly affected and amnesia is marked. The safe prolongation of the operative time is made possible by the fact that the stage of anæsthesia is followed by a stage of analgesia lasting sometimes as long as eight hours.

Since the inception of colonic anæsthesia the method of administration has undergone few changes. Experience has shown that the most successful amount is 5 ounces of ether and 2½ ounces of oil, to be given one hour before operation. Many methods of administration, such as the fractional doses, Murphy drip, *etc.*, have been tried and discarded. The use of soapsuds enemata and excessive colonic washings, *etc.*, have been found to be irritating to the mucous membrane of the bowel and have also been abandoned. With the use of 5 ounces of ether it has been found necessary to employ some supplementary anæsthesia in 65 per cent. of the cases. Nitrous oxide, ether and chloroform have been used. Small amounts of chloroform are

751

preferred, the ether seemingly counteracts the depressing effect of chloroform. There have been no complications from the chloroform. No supplementary anæsthesia is required unless the patient is actively restless.

*Technic.*—On the evening preceding the operation the patient is given a light supper of tea and toast; nothing is allowed by mouth after midnight. No laxatives are given at any time, the cleansing of the bowel being accomplished by tap-water enemata. The administration should take place in a quiet and darkened room. At 5 A.M. on the morning of the operation the tap-water enemata are repeated. One and a half hours before the operation a chloretone suppository of 10 to 15 grains is given to be followed in fifteen minutes by a hypodermic of morphine sulphate grain 1/6 to ¼. Fifteen minutes later, with the patient in the left Sims' position, the following mixture is instilled into the rectum: ether ( $\overline{3V}$ ), olive oil ( $3\overline{IISS}$ ), paraldyhyd ( $3''$ ). It is essential that this be thoroughly mixed and given very slowly, at least ten to fifteen minutes being taken. A few patients suffer cramp-like pains in the abdomen and if their coöperation cannot be obtained they will expel the mixture. At the end of an hour in which there has been absolute quiet the patient is taken to the operating room. Immediately on return to the ward a colonic irrigation of tap water is given; followed by a retention enema of 6 ounces of hot coffee. Throughout the entire preparation and operation the patient should be closely supervised to prevent the danger of the tongue falling back in the throat.

The character of the anæsthesia obtained: The patient is analgized and carried on the threshold of surgical anæsthesia. Reliance being placed on the marked analgesia properties of colonic ether. Analgesia with consciousness is present in the majority of cases. Colonic anæsthesia produces relatively more analgesia than anæsthesia and often in late stages of an operation the patient is apparently completely conscious, yet the amnesic properties are such that the patient will not remember anything that took place in the operating room. Ether oil is always safe as a light narcosis and the eye lids and other reflexes are active, the patient relaxed and analgized. The ideal colonic anæsthesia yields a quiet and peaceful respiration in which the swallowing and respiratory reflexes are retained. Some of the most difficult and time-consuming operations about the head and neck can be successfully carried out as there is no venous congestion and no excessive production of saliva and mucus. The patient can be readily aroused by talking sharply to him.

*Contraindications.*—It cannot be used with advantage in cases requiring complete muscular relaxation. As the reflexes are not abolished in the throat it is not a good anæsthesia for the ordinary tonsillectomy. It is contraindicated in diseases of the gastro-intestinal tract and rectum.

The post-operative recovery is smooth and takes place with fewer complications than in the inhalation method. There is little post-operative nausea and vomiting; fewer cardiac and pulmonary accidents. This was the deciding factor in changing from the inhalation method to the colonic and has

brought about a decrease in the death-rate and has lessened the post-operative complications, especially in head and neck cases.

*Local complications.*—In the last 800 colonics there were six cases of colitis, eighteen cases of abdominal pain, five cases of diarrhœa, four cases of irritation of the rectum, three cases of aggravation of the hæmorrhoids, a total of thirty-six. Expelled colonic (failures) twenty-seven, an excess of ether was used in eighteen leaving 94.53 per cent. of successful colonic administrations.

In the series of 2,150 operations under colonic ether there were 159 deaths. Thirty of these are recorded as errors in judgment; there were fifteen cases in which simultaneously with the removal of the carcinomatous lesion a bilateral block dissection of the neck was performed. This particular procedure gave a mortality of 44.1 per cent and consequently was abandoned. There were sixty-two surgical deaths classified as shock, infection and hæmorrhage; thirty-nine from pneumonia (non-anæsthetic); three from emboli; seven from secondary hæmorrhage; twelve from cancer cachexia; one from delirium tremens; and five from colonic anæsthesia.

*Summary of deaths from colonic anæsthetic*: (1) *Thorocoplasty.*—The operation lasted three hours and the patient left the table in poor condition and died the same day. At autopsy the colon was distended and congested. It is questionable whether colonic anæsthesia should be used in such a case, as the safety of this method depends, to a large extent, on the escape of the ether during respiration.

(2) *Excision of a carcinoma of the jaw* and cervical lymph-nodes, this operation lasted two hours, the patient returned to the ward in good shape and died on the third day. *Autopsy findings.*—Atheroma of the aorta and ulcerations of the large intestine.

(3) *Epithelioma of the lower lip.*—No operation was performed. After the administration of the colonic anæsthesia there was a short period in which he was not supervised. When the anæsthetist came he found him dead in bed with the tongue in the back of the throat. *Autopsy findings.*—Atheroma of the aorta with distinct congestion of the colon.

(4) *Radical resection of the right cervical nodes* which lasted two hours. The patient was returned to the ward in fair shape. There was difficulty in keeping the tongue forward. The nurse was called away and when she returned twenty minutes later the patient had ceased breathing. Clinically these two cases died from swallowing their tongues.

(5) *Excision of carcinoma of the face* and cervical nodes. The operation lasted five hours, the patient returned to the ward in good condition and died on the thirty-seventh day. *Autopsy findings.*—Necrosis of the rectum and bronchopneumonia. The direct cause of death was an ulcerative colitis produced by an incorrect mixture. The convalescence of two other cases who received the same mixture was delayed by ulcerative colitis.

The last fatality from colonic anæsthesia occurred in 1925. For the proper evaluation of the safety of the method it is necessary to consider the age, condition of the patient and the extent of the operation required. Over 50 per cent. of the patients were fifty and over, 420 were between fifty and sixty; 292 between sixty and seventy, 80 between seventy and eighty and 12 between eighty and ninety. One thousand four hundred and thirty-eight were head and neck cases. Twenty-four per cent. of the operations lasted three

hours, 17.2 per cent. lasted four hours; 10.1 per cent. lasted five hours; 2.4 per cent. lasted six hours; 0.7 per cent. lasted seven hours; .62 per cent. lasted eight hours. During the corresponding period, 1,532 inhalation anæsthesias were administered. The demonstrated increased safety and the diminished complication rate of colonic ether as compared to that of inhalation anæsthesia led to the abandonment of the inhalation method in all head and neck cases.

The disadvantages of colonic anæsthesia: It is not a universal anæsthetic; it does not give complete muscular relaxation; it is a complicated and time-consuming method which requires the coöperation of the patient for its administration and a competent person to watch the patient before and after the operation to prevent the swallowing of the tongue. The patient, unless under constant supervision, should never be allowed to lie flat on the back. It should not be used in emergency operations as time is required for the proper preparation of the rectum.

The advantages are: It is safe, it is controllable, as the ether can be washed out at any time. The prolonged analgesic properties of colonic ether (it may last from six to eight hours) make it possible to carry out extended operative procedures. Psychic trauma is absent, amnesia marked and the stage of excitement eliminated. The actual cautery can be used in the mouth and throat. It is useful in short-necked, obese individuals in other types of operation.

*Summary.*—The following conclusion is based on the 2,150 cases of colonic ether anæsthesia with an anæsthetic mortality of five cases (0.24 per cent.). Colonic ether anæsthesia is the safest and best for all patients with cancer of the head, neck, *etc.*, whose lesions require a general anæsthetic for their proper removal.

*Comment.*—In order to shorten the preparatory period of anæsthesia we have been employing a mixture of avertin and oil ether. We are not yet ready to pass judgment on this procedure as we still consider it in the experimental stage.

## REFERENCES

Meyer, H. W., and Robbins, B. F.: Colonic Anæsthesia. J. A. M. A., vol. lxxxiii, p. 1581, November 15, 1924.

Gwathmey, J. T.: Anæsthesia. Second Edition, New York, MacMillan Co., pp. 433–464, 1924.

Pickerill, H. P.: Facial Surgery. E. & S. Livingston, Edinburg, 1924.

Frazier, C. H.: Colonic Anæsthesia in Operations Upon the Brain. ANNALS OF SURGERY, vol. lxxxvii, p. 161, February, 1928.

Gwathmey, J. T.: Oil-Ether Colonic Anæsthesia. J. A. M. A, vol. xciii, pp. 447–452, August 10, 1929.

# RESULTS OF SPLENECTOMY IN SPLENIC ANÆMIA, HÆMOLYTIC JAUNDICE, AND HÆMORRHAGIC PURPURA *

## By John deJ. Pemberton, M.D.

### of Rochester, Minnesota

#### FROM THE DIVISION OF SURGERY OF THE MAYO CLINIC

Splenectomy for certain types of anæmia and blood dyscrasia associated with disorders of the spleen is a modern surgical venture. Its development, in the absence of accurate knowledge of the function of the spleen in health and disease, has been attained entirely through empiric failures and successes. Although the beginning of an active interest in splenectomy may be said to date back only a quarter of a century, so far the operation has been employed many hundreds of times in a wide variety of diseases; therefore ample data, with regard to the operative results in certain of the more common diseases, have long been available to establish the procedure on a firm basis.

Notwithstanding the remarkable advances made in this branch of surgery, it is unfortunate that, today, many surgeons are unacquainted with these achievements. In consequence there are undoubtedly many cases of disease in which splenectomy is indicated, but which are not correctly diagnosed, nor the proper treatment undertaken. To substantiate this statement, it is only necessary to call to mind the prevailing view of the extremely hazardous nature of the operation, and the very common mistakes made both in diagnosis and in institution of treatment; often complications rather than diseases themselves are treated.

There are several reasons to account for the fact that knowledge of the results of splenectomy has not been more widely disseminated. As the diseases benefited by removal of the spleen occur comparatively rarely, relatively few surgeons have had sufficient personal experience on which to base definite convictions. In addition, published reports, the remaining source of information, have shown an exceedingly wide variation in results. For instance, the operative mortality has been reported as 10, 30, or 40 per cent., or even higher. Unless due consideration be given to the nature and details of these reports, their apparent contradictions would tend to create doubt and confusion. Reports of operative results based on data accumulated for many years, and collected from many hospitals, often do not reflect the true status of the operation, primarily because of the variable personal factors involved. This would seem to be especially true in surgery of the spleen, in which discrepancies in diagnosis and differences in care would necessarily affect adversely the record of operative results.

It seems timely, therefore, to make a critical analysis of the results of splenectomy in the more common diseases, concerning which sufficient data are available to warrant drawing conclusions. For this purpose, a study was made of the records of all cases of splenic anæmia (including Banti's disease), hæmolytic jaundice, and purpura hæmorrhagica, in which splenectomy was performed at The Mayo Clinic between December 31, 1908, and January 1, 1931. The series comprised 326 cases in which splenectomy was performed, in 167 of which the reason for operation was splenic anæmia, in 118, hæmolytic jaundice, and in forty-one, purpura hæmorrhagica. The clinical diagnosis was made in each instance by Giffin and his associates.

Since this paper is restricted to presentation of the results of operation in these diseases, consideration of the physiology and pathologic changes relative to the spleen, the pathogenesis of the diseases, the details of operative technic, and the general indications for splenectomy in other disorders have been omitted. However, for purposes of clarity, the prominent clinical and hæmatologic features on which a diagnosis was based, are summarized briefly. Many of the data used in this study have been published in papers by W. J. Mayo, and by Giffin.

*Splenic anæmia.*—Osler defined splenic anæmia as: "Intoxication of unknown nature, characterized by great chronicity; primary progressive enlargement of the spleen which cannot be correlated with any known cause, anæmia of secondary type, with leucopenia, a marked tendency to hæmorrhage, particularly from the stomach (œsophagus), and in many cases a terminal state with cirrhosis of the liver and jaundice." It is the late stage of anæmia, that is, the stage in which there is secondary involvement of the liver, as manifested by evidences of portal obstruction and hepatic insufficiency, that today is commonly designated as Banti's disease. Strangely enough, in the presence of an enlarged spleen and associated anæmia, the diagnosis of this syndrome rests on the absence of any known etiology, and it is little wonder that many observers question whether splenic anæmia should be considered as a clinical entity, for if the cause of the splenomegaly is identified, the diagnosis of splenic anæmia is forthwith excluded.

The course of the disease in cases in which operation has not been done is progressive, without any tendency toward abatement or spontaneous recovery, and the patient ultimately succumbs, usually within a few years, as a result of recurrent excessive hæmorrhages or hepatic insufficiency. The first manifestation of this syndrome is often discovered by the patient, or in a routine examination, as enlargement of the spleen, and in some instances the organ attains considerable dimensions without other recognizable evidence of the disease. Commonly, however, there are alterations in the blood when the patient presents himself for examination. These consist of secondary anæmia of varying degrees, and extreme poikilocytosis; leucopenia with lymphocytosis is not uncommonly present, but the leucocytes may be normal in number or even slightly increased.

One or more episodes of copious hæmorrhage from the gastro-intestinal

tract, usually from œsophageal varices, occurred before operation in ninety-eight cases (59 per cent.) of this series. These are more common in the late than in the early stages of the disease, but, not uncommonly, sudden severe hæmorrhage from the gastro-intestinal tract is the patient's first warning that he is sick. Thirteen patients in this group with hæmorrhagic splenic anæmia had been treated for peptic ulcer. About a year ago during the course of a röntgenologic examination of the stomach of a patient suffering from splenic anæmia, unusual shadows were seen that suggested hugely dilated œsophageal varices; later this impression was confirmed by means of the œsophagoscope. Since then, röntgenologic examination of the œsophagus has been adopted as a routine procedure in all cases of splenic anæmia. Subsequently, similar evidence of œsophageal varices has been discovered on röntgenologic examination in other cases of splenic anæmia, in one of which clinical evidence of a hepatic condition was lacking. Likewise, a test of hepatic function, based on retention of bromsulphthalein, often indicates definite injury to the liver that otherwise would not have been suspected from clinical examination.

Of the 167 patients with splenic anæmia and Banti's syndrome who were subjected to splenectomy, sixteen died in the hospital, an operative mortality of 9.6 per cent. The sixteen deaths included one by suicide. The causes of death of the remaining fifteen patients cannot be accurately classified, for in some instances the pathologist was unable definitely to distinguish from several possible contributory conditions the immediate cause. Broadly, however, it may be said that pulmonary infections, including pneumonia, pleurisy with septicemia and hæmorrhagic œdema of the lungs accounted for four deaths, pulmonary embolism for two, portal thrombosis for three, hepatic insufficiency for four, and subdiaphragmatic abscess and peritonitis each for one death.

Of the 151 patients who survived the immediate effects of the operation, eighty are known to be living, three of them eighteen years after operation. Two are still living, fifteen and seventeen years after operation, and fifteen have lived from ten to fifteen years. Ten of the sixty-eight patients who recovered from the operation but who died later lived for more than nine years, one for eighteen, one for thirteen, and three for twelve years. Although the causes of many of the subsequent deaths were not attributable to the disease itself, it is of interest that more than a third were directly attributable to hæmorrhage.

The number of patients in the series is too small to permit accurate statistics regarding the influence of sex on the operative results, but records of the deaths in hospital suggest that the operation is more hazardous if the patients are females. Seven of the ninety-seven male patients, and nine of the seventy female patients died in the hospital. However, there were no appreciable differences in the end-results as regards the sexes. Age (Table 1) played a more definite part in the immediate as well as in the late results. If the patients are divided into two groups, it will be seen that the operative

mortality of those aged less than forty years was only half that of patients aged more than forty years; about 53 per cent. of patients aged less than forty years are still living, whereas only 40 per cent. of those who are older are alive.

Owing to the difficulty of accurately estimating the functional efficiency of the liver, it is not possible to determine with exactness the influence which secondary hepatic injury has had on the operative results. Except in the more advanced cases, in which evidences of cirrhosis and portal obstruction are obvious, it is not always possible from clinical data to judge accurately the degree of hepatic injury. Likewise, in some cases in which gross changes characteristic of advanced cirrhosis are lacking, the surgeon is often unable, from observation of the size, color, and consistence of the organ, to estimate

Table 1

## Splenectomy for splenic anemia

| Age by decades | Cases | Hospital mortality | Subsequent deaths | Living | Well | Fair | Poor | Not traced |
|---|---|---|---|---|---|---|---|---|
| 0 - 9 | 11 | | 5 | 5 | 4 | 1 | | 1 |
| 10 - 19 | 19 | 2 | 7 | 10 | 8 | 2 | | |
| 20 - 29 | 42 | 2 | 15 | 24 | 21 | 2 | 1 | 1 |
| 30 - 39 | 40 | 4 | 16 | 20 | 13 | 4 | 3 | |
| 40 - 49 | 30 | 3 | 14 | 12 | 10 | 1 | 1 | 1 |
| 50 - 59 | 20 | 4 | 8 | 8 | 7 | | 1 | |
| 60 - 69 | 5 | 1 | 3 | 1 | | 1 | | |
| Total | 167 | 16 | 68 | 80 | 63 | 11 | 6 | 3 |

the degree of injury. In livers adjudged on gross examination to be only slightly enlarged or congested, microscopic examination of specimens removed for diagnostic purposes has demonstrated repeatedly the presence of marked hepatitis or degeneration of the parenchyma. Accordingly, in the appraisal of hepatic injury the surgeon is more likely to underestimate than to over-estimate the seriousness of the condition, and unless biopsy is obtained, this potential error should be taken into consideration in the evaluation of the influence of hepatic disease on operative result. Pre-operative estimations of hepatic function, based on retention of bromsulphthalein, have been carried out in only thirty-two cases of splenic anæmia. It may be significant that the patient in this small series who died, belonged to a group of fifteen whose hepatic functional activity was believed to be impaired. As these tests have been employed only in recent years, sufficient time has not elapsed to permit a determination of their value in prognosis with regard to later results.

In Table 2 (see chart) the results of the operation have been tabulated according to the gross condition of the liver as observed by the surgeon at operation. If the cases in which the condition of the liver was not mentioned are grouped with those in which the hepatic condition was classified as normal, and all others are considered as cases in which there was more or less hepatic injury, and the results of the two groups compared, it will be seen that the secondary affection of the liver had an appreciable effect on the early results, and apparently only a slight influence on later results. The

### Table 2

### Splenectomy for splenic anemia

### Condition of liver as noted by surgeon at operation

| Condition | Cases | Hospital mortality | Subsequent deaths | Living | Well | Fair | Poor | Not traced |
|---|---|---|---|---|---|---|---|---|
| Hepatitis | 4 | | 2 | 2 | 2 | | | |
| Cirrhotic | 62 | 6 | 26 | 28 | 21 | 4 | 3 | 2 |
| Enlarged | 15 | 3 | 7 | 5 | 3 | 1 | 1 | |
| Congested | 2 | 1 | 1 | | | | | |
| Enlarged and congested | 1 | 1 | | | | | | |
| Thick, not large | 1 | | | 1 | 1 | | | |
| Adherent | 6 | | 3 | 3 | 2 | | 1 | |
| Atrophic | 6 | | 1 | 5 | 4 | 1 | | |
| Hard | 2 | | 2 | | | | | |
| Normal | 42 | 3 | 14 | 24 | 23 | 1 | | 1 |
| Not mentioned | 26 | 2 | 12 | 12 | 9 | 2 | 1 | |
| Total | 167 | 16 | 68 | 80 | 63 | 11 | 6 | 3 |

operative mortality was 7 per cent. in the former group, as compared with 11 per cent. in the latter, whereas the proportion of patients who are now living is 57 per cent. in the former, and 50 per cent. in the latter.

The sixty-two cases in which cirrhosis of the liver was present at operation form an interesting group. Of the forty-six patients who survived the operation, twenty-eight (50 per cent.) are alive. This not only furnishes proof of the wisdom of accepting for operation patients with advanced Banti's disease, but indicates the remarkable power of the liver to regenerate following removal of the diseased spleen. As pointed out by W. J. Mayo,

removal of the spleen in this disease greatly lightens the load which has been thrown on the liver by reducing, by at least 20 per cent. the volume of blood entering the portal circulation, by removing possible toxic substances originating in the spleen, and by producing adhesions for the establishment of collateral circulation.

In spite of the most gratifying benefit derived from the operation, even in many of the advanced cases, as evidenced by the improvement of the blood and of general health, and by prolongation of life, the recurrence of gastro-intestinal hæmorrhages in a large group of these cases presents a discouraging problem. In approximately 50 per cent. of the ninety-eight cases in which there was gastro-intestinal hæmorrhage before operation, there has been one hæmorrhage or more subsequent to splenectomy. Since the hæmorrhage commonly results from rupture of greatly dilated varices situated beneath the mucous membrane of the lower end of the œsophagus, it has been suggested that this complication might possibly be minimized by tying the coronary vein, with the view of reducing the enormous turgescence by breaking communication with the portal circulation. In the hope of promoting additional collateral circulation, which is, in fact, nature's means of combating portal obstruction, it would seem that some form of omentopexy is indicated in selected cases as a measure supplementary to splenectomy. Because inclusion of a segment of the omentum in closure of the wound jeopardizes healing, I prefer to incorporate it in the abdominal wall, lateral to the incision for laparotomy. After separation of the several layers of the abdominal wall for 3 centimetres from the edge of the wound, a small incision is made through the peritoneum and posterior sheath of the rectus abdominis muscle, and a segment of omentum 14 to 20 centimetres is then drawn up through this opening and sutured. Similar incisions are made in the muscle and anterior sheath of the rectus abdominis, at successive levels, each lower than the preceding one, 2.5 centimetres or more apart, and the omentum is drawn through these; the distal 5 to 8 centimetres is then buried beneath the skin.

By bringing the omentum out in a steplike manner, conditions are established for the formation of new blood channels in each layer of the abdominal wall, and on account of the oblique course of the openings, the chances of troublesome herniation are minimized. (Fig. 1.)

One or both of these procedures, ligation of the coronary vein and omentopexy, have been employed in conjunction with splenectomy in thirteen of the cases seen more recently, but there has not yet been sufficient time to permit estimation of their value in the prevention of recurrent hæmorrhages.

*Hæmolytic jaundice.*—This condition may be defined as hæmolytic disease affecting primarily the spleen and secondarily the liver, characterized by varying degrees of anæmia, by acholuric jaundice, that is, jaundice with unaltered stools and urine, splenomegaly, microcytosis, and increased fragility with active regeneration of the erythrocytes. Two types of the disease have been described, the congenital and the acquired, distinguished chiefly

by differences in the age of onset and the severity of the course of the disease. However, Giffin seriously questions whether many of the cases of the acquired type reported in the literature, should, in the absence of characteristic changes in the blood, be rightfully included as cases of hæmolytic jaundice. Regardless of the age at which the prominent features of the disease become manifest, he believes that all the cases of the series reported herewith were probably fundamentally congenital in origin.
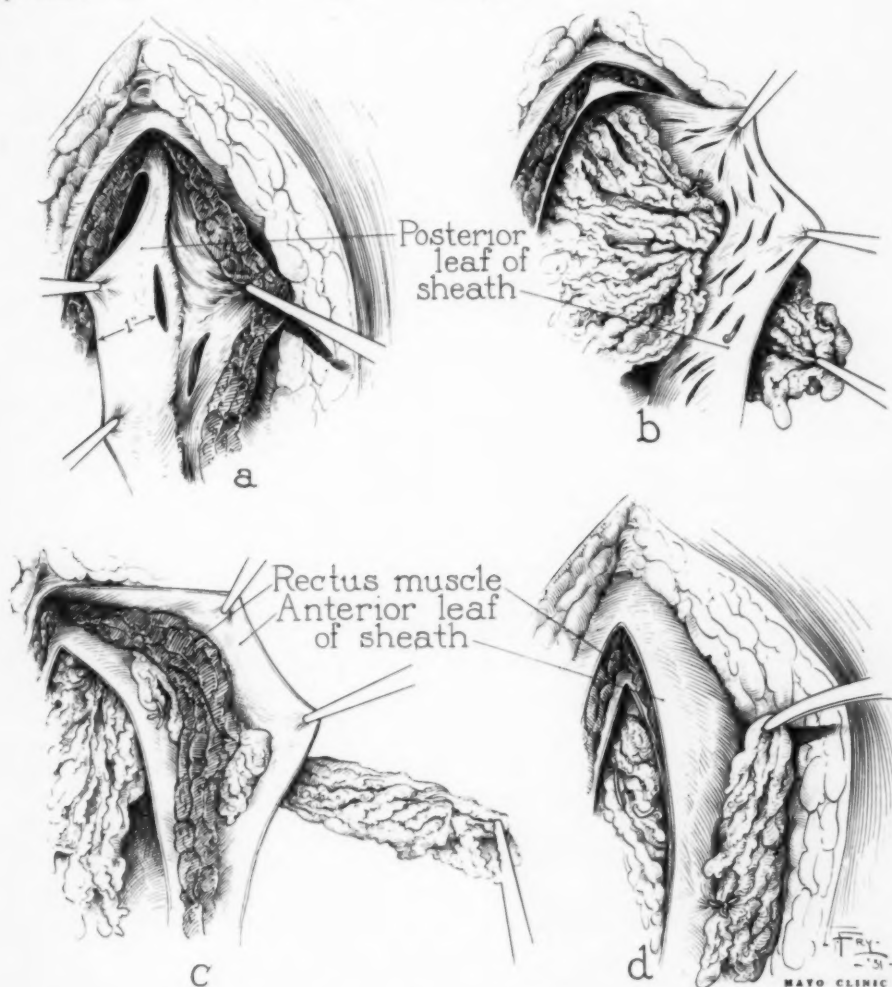


FIG. 1.—Stages of the operation for omentopexy.

Between June 30, 1911, and January 1, 1931, 118 patients with hæmolytic jaundice were subjected to splenectomy at The Mayo Clinic (Table 3). Four of the patients died in the hospital (3.4 per cent.). There was considerable variation in the course of the disease. Among children, and adolescent patients, it was for the most part continuously mild and chronic; the health of the patient apparently was little affected. In other cases the chronic course

was interrupted by one or more attacks of "crisis," characterized by malaise, abdominal pain, fever, increase in size of the spleen, deepening of the jaundice, and increase in anæmia. Not uncommonly, the crisis is mistaken for biliary colic, and operation is advised. Conclusive evidence of disease of the gall-bladder, with and without stones, occurred as a secondary complication in eighty-one cases (68.6 per cent. of the series) and in twenty-three of these, operations on the biliary tract had been performed elsewhere, presumably without knowledge of the presence of the primary disease. In none of these cases were gall-stones found in the common bile-duct, although in several cases a direct van den Bergh reaction was obtained.

Operative data were suggestive of secondary affections of the liver in fifty-five cases. Cirrhosis of the liver was noted by the surgeon in seven cases, and in six cases ascites was found, but the condition of the liver was

## Table 3

### Splenectomy for hemolytic jaundice

| Age by decades | Cases | Hospital mortality | Subsequent deaths | Living | Well | Fair | Poor |
|---|---|---|---|---|---|---|---|
| 0 — 9 | 21 | | 2 | 19 | 16 | 3 | |
| 10 — 19 | 20 | | 2 | 17 | 13 | 4 | |
| 20 — 29 | 38 | 2 | 2 | 32 | 28 | 2 | 2 |
| 30 — 39 | 24 | 1 | 4 | 18 | 15 | 1 | 2 |
| 40 — 49 | 11 | | 1 | 9 | 8 | 1 | |
| 50 — 59 | 4 | 1 | | 3 | 2 | 1 | |
| Total | 118 | 4 | 11 | 98 | 82 | 12 | 4 |

not mentioned. In the remaining thirty-two cases, the liver was described as enlarged, congested, hard, or adherent.

On comparing the results of the operation in these cases with the results in cases in which the liver was normal or was presumed to be normal, it would seem that the secondary affection of the liver exerted a decisive influence. The operative mortality was 5.4 per cent. in the former group, as compared to 1.6 per cent. in the latter, whereas the proportion of patients who survived the operation and who are living, is 80 per cent. in the former group, and 90 per cent. in the latter.

Evidence of the benefits of splenectomy usually becomes apparent within five or eight days after the operation; the jaundice then begins to fade and it disappears completely within two or three weeks. In many instances the patient is now free of jaundice for the first time in his life. Rapid and progressive improvement of the anæmia is also commonly noted before the patient is dismissed from the hospital. However, certain of the most char-

acteristic changes in the blood, such as microcytosis and increased fragility of erythrocytes, usually do not disappear after removal of the spleen.

The late results are equally gratifying. Approximately 86 per cent. of the patients who recovered from the operation are living, and 83 per cent. of these are in good health. Of the eleven patients who died subsequent to recovery from splenectomy, the cause of death of six was not attributable to the effect of the operation or the disease. The remaining four died of conditions probably secondary to the hæmolytic jaundice, such as cirrhosis of the liver, gastro-intestinal hæmorrhage, and severe anæmia.

In view of the low operative hazard, and the exceedingly satisfactory results of surgical procedures, and considering the high incidence of hepatic and biliary complications in the untreated cases, I believe that splenectomy should be advised as the safest method of treatment in all cases of hæmolytic

## Table 4

### Splenectomy for hemorrhagic purpura

| Age by decades | Cases | Hospital mortality | Living | Well | Fair | Poor |
|---|---|---|---|---|---|---|
| 0 - 9 | 7 | | 7 | 6 | | 1 |
| 10 - 19 | 12 | | 12 | 11 | 1 | |
| 20 - 29 | 14 | | 14 | 13 | 1 | |
| 30 - 39 | 5 | 1 | 4 | 4 | | |
| 40 - 49 | 2 | | 2 | 2 | | |
| 50 - 59 | 1 | 1 | | | | |
| Total | 41 | 2 | 39 | 36 | 2 | 1 |

jaundice; certainly in the severe cases and in those in which there is a history of recurrent crisis.

*Hæmorrhagic purpura.*—From March 7, 1923, to January 1, 1931, splenectomy was performed for hæmorrhagic purpura in forty-one cases, with two deaths (Table 4).

Hæmorrhagic purpura is an idiopathic hæmorrhagic disease, characterized by hæmorrhage from the mucous membranes, petechiæ, varying degrees of secondary anæmia, diminution in the number of blood platelets, and usually slight enlargement of the spleen. It occurs in two forms, the acute and the chronic relapsing. It is essentially a disease of early life, although occasionally patients past middle life are affected. In this series only three patients were aged forty years or more. The incidence was twice as great in females as in males. Crops of petechiæ and hæmorrhages from the mucous membranes were often the only prominent clinical features of the disease. The bleeding varied in severity from slight oozing usually from the gums,

nose and uterus, to intractable hæmorrhages. One patient died as a result of cerebral bleeding.

The typical changes in the blood in these cases were: (1) Reduction in the number of platelets; (2) prolonged bleeding time; (3) delayed retractility of the clot; (4) normal coagulation time, and (5) secondary anæmia with evidence of the normal regeneration of the erythrocytes. The capillary resistance test, indicating abnormal permeability of the capillaries, was positive in all cases in which it was employed.

Since the principal indication for splenectomy in hæmorrhagic purpura is a definite diagnosis, it is extremely important to distinguish this disease from others in which hæmorrhagic tendencies are common, notably, aplastic anæmia, hæmophilia, and acute leucemia. This usually can be readily accomplished by correlating the results of detailed examination of the blood with the clinical history. However, the diagnosis may at times be extremely difficult, and failure of an accurate diagnosis undoubtedly accounts for many of the poor results reported in the literature.

In but few diseases in which symptoms are so alarming are the beneficial results of operation so dramatic as in hæmorrhagic purpura treated by splenectomy. It occasionally happens that the patient is bleeding at the time of operation, and sometimes the hæmorrhage ceases before the patient is returned to his room.

An appreciable rise in the number of the blood platelets has been noted within twenty-four hours after removal of the spleen, and often by the third day the platelet count is within normal range. The thirty-nine patients who survived the operation are alive, and all but three are in good health. Giffin observed, in some cases, mild recurrence of hæmorrhage, which ceased following elimination of infected tonsils or teeth.

### CONCLUSIONS

From these data it is evident that, contrary to the prevalent view of the hazardous nature of splenectomy, the operative results (6.7 per cent.) compare favorably with those of other major abdominal operations, and in spite of the relatively common mistakes made in diagnosis, the conditions associated with disorders of the spleen and amenable to splenectomy can readily be identified, provided complete data concerning the blood are correlated with the clinical history.

Since the operative results in cases of splenic anæmia are largely contingent on the presence of secondary affections of the liver and portal obstruction, the need for early diagnosis and operation is apparent. Enlarged spleens, in the absence of definite etiology, should be considered as instances of the splenomegaly of potential splenic anæmia, and operation should be advised. However, clinical evidence of the presence of hepatic injury should not in itself be considered a contra-indication to splenectomy, since many patients in this group lived active lives for many years after removal of the

spleen. The relative frequency of recurrent hæmorrhages in these cases indicates the need for additional effort toward their prevention, such as ligation of the coronary vein and omentopexy.

In view of the high percentage of secondary affection of the liver, the small operative hazard, and the extremely favorable late results, splenectomy would seem to be the safest procedure in all cases of hæmolytic jaundice.

Splenectomy for hæmorrhagic purpura is a comparatively safe procedure, and the benefits are lasting. In the severe cases, delay of operation is fraught with danger.

## REFERENCES

Giffin, H. Z.: Splenectomy. Surg., Gynec., and Obstet., vol. xlv, pp. 577–585, November, 1927.

Giffin, H. Z.: Diseases of the Spleen. Oxford Medicine. (In press.)

Mayo, W. J.: The Splenomegalia. Coll. Papers, Mayo Clinic and Mayo Foundation, vol. xx, pp. 589–596, 1928.

Mayo, W. J.: The Enlarged Spleen. South. Med. Jour., vol. xxi, pp. 13–16, January, 1928; California and West Med., vol. xxx, pp. 382–386, June, 1929.

Mayo, W. J.: Surgical Aspects of Diseases of the Lymphoid Organs, with Special Reference to the Spleen: with a Statistical Report of the Results Following the Removal of the Diseased Spleen in 530 cases. Coll. Papers, Mayo Clinic and Mayo Foundation, vol. xxi, pp. 631–645, 1929.

Rowntree, L. G., Walters, Waltman, and McIndoe, A. H.: End-results of Tying of the Coronary Vein for Prevention of Hæmorrhage from Œsophageal Varices. Proc. Staff Meetings of Mayo Clinics, vol. iv, pp. 263–264, September 4, 1929.

# ABSCESS OF THE LIVER

## By Frank K. Boland, M.D.

### of Atlanta, Ga.

FROM THE EMORY UNIVERSITY MEDICAL SCHOOL

ABSTRACTS are herewith submitted of nineteen cases of abscess of the liver treated in the Emory University division of the Grady (Municipal) Hospital, during the five-year period, 1926-1931. The first fourteen are cases caused by the *endamœba histolytica*, while in the remaining five cases pyogenic bacteria are the etiologic agents. All the patients were native-born Georgia negroes, and only one patient with amœbic disease ever lived outside the state. The clinical history suggests malaria as a causative factor in several instances, but all the amœbic cases were negative for this plasmodium. More than 50 per cent. of the patients entering this hospital give positive blood Wassermanns. It so happened that only two of these patients had syphilis. During the same five-year period, among approximately the same number of white patients admitted to the hospital, 25,000, there were two cases of amœbic hepatic abscess.

A review of the cases of amœbic abscess in the series invites comment concerning the clinical aspects. It has been shown repeatedly that amœbic dysentery and abscess are not diseases confined to the tropics. The term tropical abscess, meaning amœbic abscess, should be discarded. Amœbic abscess also is regarded as being single, and pyogenic abcess as being multiple. One of these patients had multiple amœbic abscess; two patients had single pyogenic abscess. Males are more susceptible to the disease than females, in a proportion of 5 to 1, and in the state of Georgia the colored race is considerably more susceptible than the white race. Most authors mention alcoholic addiction as a predisposing factor in the etiology of amœbic abscess. Only one patient among these fourteen used alcohol excessively.

Only five patients gave a history of bloody dysentery preceding or accompanying abscess formation, and in but one patient could the amœba be demonstrated in the stool. The *endamœba histolytica*, or its encysted form, was recovered from the pus or the abscess wall in eleven of fourteen patients. The three other patients present such typical clinical findings of amœbic abscess that the diagnosis seems warranted. Sometimes amœbæ may be found in the first escape of fluid from the abscess cavity, or by scraping the abscess wall. Again, they may not appear in the discharge until the second or third day after operation. In none of these patients was jaundice present, although jaundice is not easily discernible in the black race.

Amœbic abscess of the liver is divided into the acute and the chronic form. There are typical examples of both kinds in the series, but three cases are described which might be placed in a third classification, the sub-

acute. The symptoms are not so rapidly overwhelming as in the acute form, and yet do not spread over such a long period of inactivity as in the chronic variety. In acute abscess the onset is sudden, with severe abdominal pain, which appears to be worse at night. There are chills, high fever and extreme prostration. Then follows the rather sudden appearance of a large tender mass in the right upper quadrant. Bloody dysentery may or may not precede or accompany the other manifestations. Vomiting and other



Fig. 1.—Amœbic abscess of liver.

gastro-intestinal symptoms may be present, suggesting the existence of perforated gastric ulcer, with subphrenic abscess formation. The disease may terminate fatally in a few days. Instances have been mentioned in which liver abscess has perforated into the stomach, or through the diaphragm into the pleura or a bronchus. No such cases were observed in this group.

The chronic variety may exist for many years, with alternating appearance and subsidence of symptoms from time to time. The prognosis is good. There are apt to be cough, night sweats and weakness, and tuberculosis is

suspected. The cough may be due to the pressure of the elevated liver against the diaphragm. Harrington[1] reports five cases of amœbic hepatic abscess, in four of which the lesion was first diagnosed as thoracic rather than abdominal. Two of the patients in the present group were operated upon twice for amœbic abscess, occurring in different parts of the liver at widely separated times.

Rogers, (2), in his classical monograph on amœbic abscess, calls attention to the presence of the relatively low percentage of polymorphonuclear leucocytes. This probably is true in the chronic form, in which only amœbæ are causative factors. Although demonstrated bacteriologically in only two of these cases, in which staphylococci were found, it appears that acute abscess generally means mixed infection, and both the total leucocyte count and the percentage of polymorphonuclears are high.

Röntgen examination of suspected hepatic abscess cases is not consistently helpful in the diagnosis. The demonstration of an elevated diaphragm is valuable information, but sometimes it seems difficult to determine whether the pathology is below or above the diaphragm. Several of these cases are reported as showing pleural or pulmonary lesions, as in Harrington's experience. LeWald's[3] recommendation offers a solution of the problem. A lateral thoracic röntgenogram always should be taken. It brings out the complete curve of the diaphragm, and seldom fails to differentiate between disease below and above the muscle. In some cases such pathologic conditions may coexist. The aspiration of a liver abscess, and replacement of the fluid with lipiodol, furnishes a graphic röntgenogram of the abscess cavity. One case in the series presented on percussion a large area of resonance just above the liver. This was puzzling until the röntgenogram disclosed a collection of gas produced by a gas-forming organism from a ruptured hepatic abscess.

The diagnosis of amœbic liver abscess would be made easier if the amœba could be found in the stools in more cases. The history, symptoms and signs are variable, and often prolonged study of patients is necessary. One sign always is present, if it can be established—an enlarged liver. The problem then is to eliminate syphilis, malignant disease, cirrhosis and other causes of enlarged liver.

Rogers protests against open operation in amœbic hepatic abscess, which he claims invites secondary infection and greatly increases the mortality. He urges treatment by repeated aspiration. This method may be indicated in abscess due solely to the *endamœba histolytica*, if one can locate the involved area without exposing the liver. In the majority of cases in this group, however, in which mixed infection was presumed to be present already, more radical and more certain surgical incision and drainage seemed to be the method of choice. Usually the procedure should be carried out in two stages, as in operating upon lung abscess. If this rule had been followed consistently in the present series, probably two deaths would have been avoided. Since an amœbic dysentery the adequate administration of emetine

hydrochloride is said to prevent the development of liver abscess, the continuation of the drug, in one-grain doses daily, given hypodermically, furnishes logical preparation for operation. Solutions made from quinine, emetine, amodin, *etc.*, were used in irrigation after operation, but their value was not determined.

Five cases are classed as acute amœbic abscess; six cases as chronic, and three as subacute. The abscess was located in the right lobe invariably. In six patients the approach to the liver was through the muscular abdominal wall, and in six the liver was reached through rib resection. The abscess area was easily recognized. The pleura was incised in three patients, once accidentally, with a fatal outcome. Two stages were employed in three cases. In the first stage the liver was sutured to the abdominal or chest
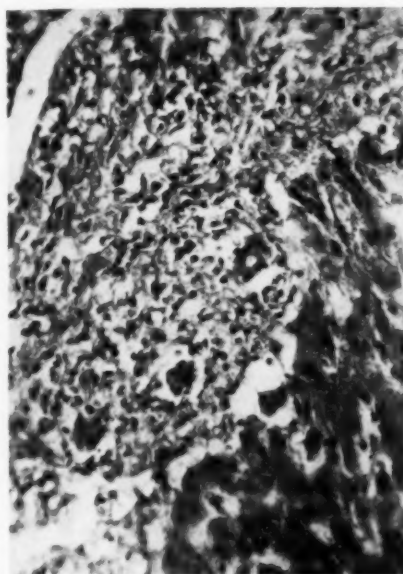


FIG. 2.                                          FIG. 3.

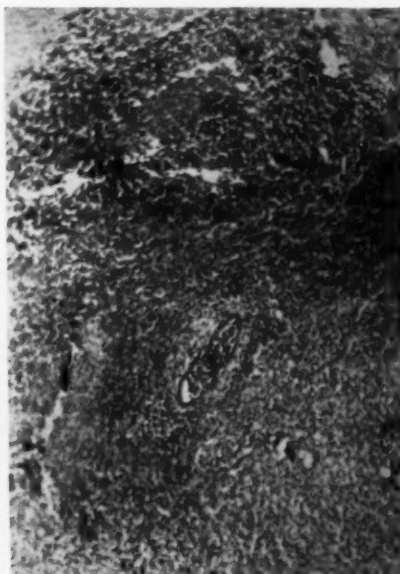FIG. 2.—Amœbic abscess of liver, high-power microphotograph showing wall of abscess with healing process.
FIG. 3.—Amœbic abscess of liver, low-power microphotograph showing necrosis of margin of abscess. Blood-vessel filled with white corpuscles.

wound, or the wound packed so as to isolate an area for opening the abscess twenty-four hours later. Local anæsthesia was the usual preference. Five deaths occurred among the amœbic cases, a mortality of 35.7 per cent.

There were two recoveries among the five patients with liver abscess due to pyogenic organisms. One abscess was caused by a stab-wound of the liver, and the other followed a gunshot-wound. Both were single abscesses, streptococci and colon *bacilli* being found in the abscess due to the stab-wound, and the colon *bacillus* alone being recovered from the abscess due to the gunshot-wound. Of the three patients who died, no history could be obtained in two. The third patient developed liver abscess from a

49

splenectomy performed two months previously for splenomegaly due to splenitis. These three abscesses were multiple, the colon *bacillus* being present in one case, and the streptococcus in the other two cases. Differential pre-operative diagnosis between liver abscess due to amœbæ and abscess caused by pyogenic bacteria, with negative stools, is rarely made, except in traumatic cases. Certainly, the prognosis is far less favorable in multiple abscess than in single abscess.

## CASE REPORTS

Case I.—Male, aged forty-two. Admitted October 27, 1926. Four months before admission, the patient first noticed pain in the upper abdomen, which was followed in a few days by the rather sudden appearance of a mass in the region of the liver. At about the same time bloody dysentery appeared. He was weak, and apparently had lost considerable weight. The liver, or a mass continuous with the liver, extended to within 2 centimetres of the umbilicus. The mass was smooth, round and pulsating, but it was not expansile, and no bruit could be heard. It felt cystic rather than solid. Rectal examination showed marked redness of the mucosa, but no ulceration. Röntgen study reported deformity of the duodenum, due to pressure, and 4 centimetres' elevation of the right side of the diaphragm. Temperature 103°, pulse 85. Leucocytes 20,400; polymorphonuclears 62 per cent. The stools were found loaded with *endamœba histolytica*. The examination otherwise was essentially negative. The diagnosis was amœbic abscess of the liver. Following the hypodermic administration of emetine hydrochloride grain 1 daily for three days, on November 5, under local anæsthesia, through a right rectus incision, a single cavity in the right hepatic lobe was emptied of 750 cubic centimetres chocolate-colored, odorless fluid characteristic of amœbic abscess, and tube drainage instituted. Amœbæ were not demonstrated in this fluid; the abscess wall was not scraped. Three days later amœbæ were found in the discharging pus. Alcresta tablets of ipecac were given the patient after the operation. January 7, 1927, the patient was sent home with normal temperature, and only a small drain in the wound. Three days afterwards he returned on account of fever, and swelling in the line of the incision. This was reopened, with further discharge of pus from the liver cavity. February 1, he was dismissed as cured. In May, 1931, he was readmitted to the hospital with the development of another amœbic abscess in a different portion of the right hepatic lobe. The patient was not very sick this time. The abscess was drained through resection of the ninth rib in the mid-axillary line. Amœbæ were demonstrated in the pus. The patient left the hospital in three weeks in good condition, returning to the out-patient clinic to be dressed.

Case II.—Male, aged forty-two. December, 1926, first noticed that his abdomen was swollen, but did not seem to be very sick, and was able to continue with his work. He may have had diarrhœa before this time, but was not certain. February, 1927, he had headache and nausea, and grew very weak. There was pain in the chest, and dyspnœa, but no cough nor night sweats. When he entered the hospital, September 6, 1927, his liver could be felt 10.5 centimetres below the costal margin. Temperature was normal, and did not reach 100° all the time he was in the hospital. Leucocytes 12,250; polymorphonuclears 59 per cent. He had been a heavy drinker. The röntgen diagnosis was fluid in the right chest. September 8, an aspirating needle was introduced through the ninth interspace, thinking the pleural cavity was being reached. Instead, the withdrawal of 3,400 cubic centimetres of thick brown odorless fluid caused the abdominal distention to disappear. The swelling gradually recurred, however, and fifteen days later, under local anæsthesia, an abscess in the right lobe of the liver was drained in one sitting, by resecting the ninth and tenth ribs. Three days later the encysted form of the *endamœba histolytica* was found in the pus. The patient was dismissed, November 2, as cured.

CASE III.—Female, aged twenty. In June, 1926, she had dysentery for three months, passing blood and mucus. This subsided, but in August, 1927, recurred with increased severity. At this time there were "slow aching" abdominal pains, which were worse at night. One week before admission the pain took on the nature of cramps, accompanied by nausea and vomiting. A large amount of brown sputum was expectorated. She lost twenty pounds in weight, and was very weak. Upon admission, September 27, 1927, the patient was found to have a bulging in the right upper abdomen, extending 7.5 centimetres below the costal margin. The mass was tender, and the right rectus muscle was rigid. Temperature 103°, pulse 110. Leucocytes 17,000; polymorphonuclears 58 percent. Wassermann four plus. Patient not addicted to alcohol. Röntgenogram showed an enlarged liver, with elevation of the diaphragm 5 centimetres. Repeated examination of stools failed to reveal either blood or amœbæ, but the clinical diagnosis was
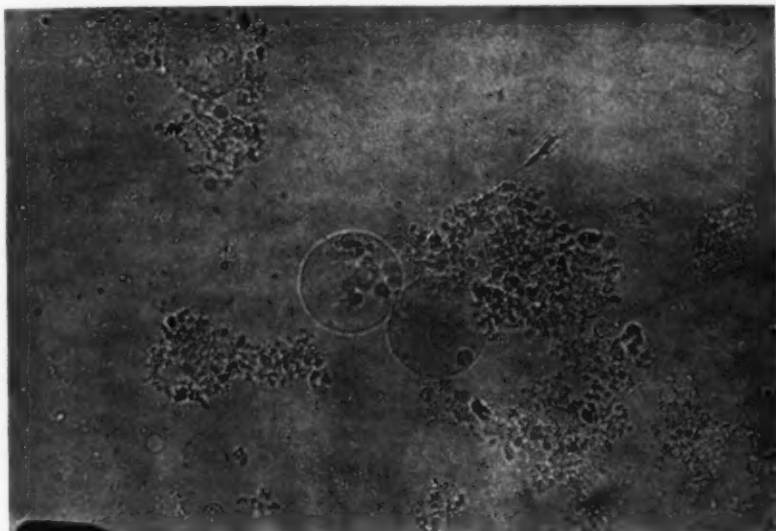


FIG. 4.—Microphotograph showing endamœbæ histolyticæ from liver abscess. Red blood corpuscles in amœbæ.

amœbic abscess of the liver. The patient refused to have an operation, and signed a release October 2.

CASE IV.—Male, aged fifty. Six months before admission the patient complained of soreness across the abdomen, and two weeks later noticed abdominal swelling. Afterwards he had bloody mucus dysentery. He entered the hospital June 2, 1928, and was found to have an enlarged liver, extending 7 centimetres below the costal border. The mass was tight and smooth, and somewhat tender. The stools contained mucus and blood, but no amœbæ were seen. The temperature was normal, lecucocytes 4,360, polymorphonuclears 51 per cent. June 3, under local anæsthesia, through a right rectus incision, 250 cubic centimetres chocolate-colored fluid were evacuated from the right lobe of the liver, and tube drainage used. June 6, staphylococcus in pure culture was obtained from the wound, and June 8, amœbæ. The temperature rose to 100° immediately after the operation, but the next day was normal, and remained so. The patient was given emetine hypodermically, and the wound irrigated with emetine 1 per cent. He was dismissed five weeks after operation as well.

CASE V.—Female, aged twenty-nine. This patient had been sick for four and a half years before she came to the hospital. In August, 1924, she had recurrent severe attacks of pain in the right abdomen lasting for three weeks. She had as many as ten or fifteen short paroxysms in twenty-four hours, mostly at night. These pains sub-

sided, but returned in the same way in October, 1924, when she vomited frequently, and grew very weak. Again, she was comparatively well until September, 1926, when the pain appeared in the left side, but she thought the right upper abdomen was swollen. In January, 1928, she had dull aching in the epigastrium. She belched a great deal of gas, usually about two hours after eating. Upon entering the hospital, March 26, 1928, she had a mass reaching 10 centimetres below the costal margin. Temperature 99.8°, pulse 70; leucocytes 14,950, polymorphonuclears 63 per cent. Stools negative. The röntgenogram showed the right diaphragm elevated 8 centimetres. The röntgen diagnosis was tumor of the ovary or kidney. In a conference of the surgical staff, while most members thought 'the condition was liver abscess, the possibility of liver or pancreatic cyst or tumor was considered. April 11, under gas anæsthesia, through an abdominal incision, a hepatic abscess, with thick fibrous wall, was disclosed
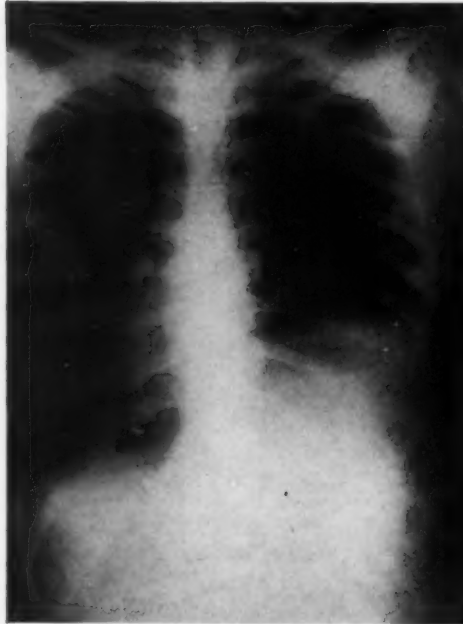


FIG. 5.                                    FIG. 6.

FIG. 5.—Liver abscess showing elevation of diaphragm.
FIG. 6.—Liver abscess injected with lipiodol outlining cavity in liver.

in the right lobe, and 4,500 cubic centimetres chocolate-colored fluid removed. Encysted amœbæ were found in the pus. The patient died eight days after operation from peritonitis, with temperature 107°.

CASE VI.—Male, aged twenty-six. This patient entered the hospital March 4, 1929, and died the next day without being fully studied. He gave a history of four weeks' illness, beginning with vomiting, colicky pains, daily chills, weakness and diarrhœa. Autopsy showed one large liver abscess, and several small ones. Amœbæ were recovered from the walls of the abscesses.

CASE VII.—Male, aged thirty-six. Entered hospital November 12, 1929, with history of fullness in the epigastrium and shortness of breath for the preceding six months, getting progressively worse. He had epigastric pain which seemed to come one hour after meals, nausea and vomiting, and a productive cough, which did not show tubercle bacilli. The liver reached 8.5 centimetres below the costal margin. Temperature was 101.4°, pulse 100, leucocytes 9,500, polymorphonuclears, 74 per cent. Röntgenogram showed the right diaphragm 5 centimetres above normal. Gastro-intestinal

series negative except for pressure deformity of the duodenum. November 23, under local anæsthesia, tenth rib was resected, aspiration revealed no pus. Then the ninth rib was resected, and the liver sutured to the wound. During the last procedure the pleura was accidentally opened, and closed. Four days later a large subphrenic abscess was opened, and characteristic amœbic fluid evacuated, but no amœbæ could be demonstrated. The patient died on the table.

CASE VIII.—Male, aged twenty-six. Sick eight weeks before admission, with pain in right side, hemoptysis and dyspnœa. No dysentery. On entering the hospital, December 26, 1929, the leucocytes were 10,200, polymorphonuclears 85 per cent., temperature 101.6°, pulse 100. Many pus-cells in the urine. There was a mass in the right side, diagnosed as pyelonephritis, polycystic kidney, *etc*. Fluoroscopy showed the right diaphragm raised to the third rib. January 1, 1930, under novocaine, a large abscess in the right lobe of the liver was evacuated, positive for amœbæ. The patient ran a septic course and died January 12.

CASE IX.—Male, aged thirty-six. Patient stated that nine years before admission, December 27, 1929, he had bloody dysentery, and was operated upon for a liver abscess. Nine months before admission he had another attack of dysentery, which subsided. Six months later the present trouble started with pain in the right upper quadrant and dyspnœa. The liver was enlarged and very tender. Temperature 101.3°, pulse 90, leucocytes 12,100, polymorphonuclears 78 per cent. The fluoroscope suggested fluid in the right chest. January 1, 1930, under gas anæsthesia, a large amount of chocolate-colored pus was removed from the liver through an abdominal incision. The temperature dropped to normal, and remained so. No amœbæ were found, but the history and clinical findings were those of amœbic hepatic abscess. The patient left the hospital February 14, marked as improved.

CASE X.—Male, aged thirty-six. Admitted September 15, 1930. For many years the patient drank a pint of whiskey daily. One month before entering the hospital, while lifting a heavy sack of meat, he felt a sudden sharp pain in the epigastrium, which caused him to quit work for the day. He was able to work as usual until September 2, when he had a recurrence of the attack, more marked, compelling him to seek his bed. September 6, he had a severe chill. The pain grew worse, and was accompanied by vomiting. On admission his pulse was 86, temperature 100.4°, respiration 22. A few hours later he had a chill, followed by temperature 103.6°, leucocytes 18,250, polymorphonuclears 80 per cent. Urine negative. Wassermann three plus. There was a firm rounded mass in the liver region, extending 13 centimetres below the costal margin. The mass was somewhat tender, and there was no expansile pulsation nor bruit. There was no history of dysentery, but there was occult blood in the stools. Röntgenogram showed normal lungs, with the right diaphragm elevated 5 centimetres. The mass apparently increased in size, and on September 23, under local anæsthesia, through a right rectus incision, 600 cubic centimetres chocolate-colored fluid were removed, and the cavity drained. This fluid was negative for amœbæ, but four days later amœbæ were found in the draining pus. The patient had a normal convalescence, and was dismissed November 2 as cured.

CASE XI.—Male, aged thirty-six. Three months before admission the patient complained of a dull aching pain in the right upper quadrant, mostly at night. This continued for three weeks, when he grew so weak he had to quit work. He then began having night sweats, but no bloody dysentery. He lost weight, and developed pain in the right shoulder. Later the pain was felt in the chest, and he began to cough. On entering the hospital, April 19, 1930, his right lung was flat at the base, and a friction sound was present over the area. The liver dullness apparently was not increased below, but the liver was tender above, and the abdomen was somewhat rigid. Temperature 103.3°, pulse 110, leucocytes 17,200, polymorphonuclears 88 per cent. Sputum negative. The fluoroscope revealed elevation of the right diaphragm. April 19, under local

anæsthesia, first-stage thoractomy performed; April 22, second stage, with evacuation of typical amœbic fluid. April 24, amœbæ found in discharging pus. May 21, patient sent home as cured.

CASE XII.—Male, aged nineteen. Sickness started January, 1930, with pain in upper abdomen, fever, night sweats, prostration, no chills. Admitted May 20, with temperature 100°, pulse 140, leucocytes 15,000, polymorphonuclears 81 per cent. The liver was tender, 9 centimetres below costal border. No history of dysentery, stools negative. Röntgen report was right diaphragm high. Diagnosis.—Amœbic abscess of liver. May 27, under local anæsthetic, pleura sutured to diaphragm through the ninth rib. May 28, abscess in right lobe of liver emptied of 500 cubic centimetres chocolate-colored fluid. Numerous amœbic cysts disclosed. The patient's pulse and temperature dropped to normal a few days after the operation, and remained normal. June 20 discharged as well.

CASE XIII.—Male, aged thirty-eight. Patient came to hospital October 6, 1930, apparently very ill, temperature 101°, pulse 120. The liver was very tender, and the liver dulness greatly increased, extending 10 centimetres below the costal margin. The patient's sickness began suddenly three weeks before admission, with pain in the right shoulder, no nausea or dysentery. The diagnosis was liver abscess. No röntgen work or blood counts were done prior to the operation, which was performed twenty-four hours after he entered the hospital. Under novocaine anæsthesia, through excision of segments of the eleventh and twelfth ribs, an enormous ruptured hepatic abscess was found, containing thick, brownish-yellow pus, with foul odor. Ample drainage was provided. The cystic form of the amœba was found a few days later. Following operation the patient ran a septic course, with leucocytes varying from 15,000 to 32,000, and the polymorphonuclears from 79 per cent. to 94 per cent. November 20, röntgen examination following lipiodol injection into sinus, showed abscess cavity in liver. December 21, the patient left the hospital as improved.

CASE XIV.—Female, aged seventeen. She entered the hospital April 9, 1931, with a history of three weeks' illness marked by high fever and bloody dysentery. The abdomen was very tender, rigid and bulging, the liver reaching 7 centimetres below the costal rim. Pulse 140, temperature 102°-104°, leucocytes 24,000, polymorphonuclears 85 per cent., erythrocytes 1,150,000, hæmoglobin 35 per cent. She had night sweats, nausea and vomiting. The röntgen diagnosis was diaphragmatic pleurisy, the right diaphragm being elevated. Wassermann three plus. Bloody stools negative for amœbæ. April 15, under novocaine anæsthesia, through a right rectus incision, 750 cubic centimetres foul, greenish-yellow pus were obtained from liver abscess. Amœbæ were demonstrated. The patient continued very sick, developed left lower lobar pneumonia, and died April 18.

CASE XV.—Male, aged twenty-five. Patient entered the hospital December 7, 1927, in a delirious condition. Impossible to obtain history. Temperature 102°, pulse 130. Died the next day. Autopsy showed multiple abscesses of the liver, *B. coli* present.

CASE XVI.—Male, aged thirty-nine. Patient had chills and fever in Jamaica in boyhood. In January, 1915, he had severe cramping pain in left upper abdomen, which lasted one year, and later recurred. Two days before admission, May 27, 1928, he experienced another pronounced attack. There was a tumor mass in the left upper abdomen, diagnosed as enlarged spleen or kidney. Malarial parasites could not be demonstrated in the blood. Temperature 103°, which dropped to normal after operation. Wassermann negative. May 22 splenectomy was performed under gas-ether anæsthesia. The spleen weighed 1350 grams and measured 10 by 20 centimetres. The diagnosis was splenomegaly due to splenitis. The wound became infected, the patient ran considerable temperature, but apparently got well, and left the hospital June 19, with a small draining sinus. July 2, 1928, the patient was readmitted with dyspnœa, swollen feet and liver extending 5 centimetres below the costal border. The temperature was 101°, then became subnormal. Hepatic abscess was diagnosed, but aspiration

was negative. Blood culture showed streptococcus pyogenes. Death, July 30. Autopsy revealed multiple abscesses of the liver.

CASE XVII.—Female, aged twenty-one. Entered hospital March 7, 1930, with history of being sick since February 21, with headache, followed soon by severe subcostal pain on the left side. A short time afterwards the pain enveloped the entire epigastrium, being boring in character. There were no chills or cough. The abdomen was slightly distended, rigid, did not move on respiration, and was markedly hypersensitive. There was no dysentery. An indefinite mass was made out in the abdomen. Temperature 103°, pulse 136, leucocytes 12,900, polymorphonuclears 80 per cent. The patient died three days after admission. Autopsy report was multiple liver abscesses from which streptococci were grown.

CASE XVIII.—Male, aged twenty-seven. Entered hospital August 27, 1930, with history of stab-wound of right chest four weeks previously, for which he did not receive hospital treatment. Two days before coming to the hospital he complained of pain in the right upper abdomen, dyspnœa, cough and chills. Temperature 104°, pulse 120, respiration 22. Liver tender, and area of dulness somewhat increased. Röntgen investigation pointed to pus above the diaphragm. After several unsuccessful attempts to find pus by aspiration, three days after admission, under local anæsthesia, 200 cubic centimetres foul yellow pus were evacuated from cavity in the right lobe of the liver, through the ninth rib, in a two-stage operation. The bacteriological report was streptococcus and B. coli. It was necessary to reopen the abscess twice afterwards, but March 6, 1931, the patient finally was discharged as well.

CASE XIX.—Male, aged twenty-seven. Entered the hospital November 16, 1930, having been admitted one month previously for multiple gunshot-wounds, involving the chest, abdominal wall, penis and scrotum. He had no operation for this trouble, and was discharged as well three weeks later. Four weeks before present admission he had sharp pain in the right side, which soon spread over the whole right abdomen. The abdomen was rigid and tender, and apparently a liver mass was present, extending 7 centimetres below the costal rim. Temperature 101°, pulse 100, leucocytes 18,000, polymorphonuclears 76 per cent. Stools negative. No Wassermann was made. November 18, under gas-novocaine anæsthesia, through right rectus incision, 300 cubic centimetres foul pus were removed from a cavity in the right lobe of the liver. B. coli was reported. December 15 patient was discharged as well.

## REFERENCES

[1] Harrington, Stuart W.: Amœbic, Hepatic, Subphrenic and Pulmonary Abscesses. Archives of Surgery, vol. xxi, No. 6, Pt. 2, p. 1146, December, 1930.

[2] Rogers L.: Amœbic Liver Abscess: Its Pathology Prevention and Cure. Lancet, vol. i, pp. 463, 569, 677, March 11, 18, 25, 1922.

[3] LeWald's Discussion of Harrington's Paper. Quoted above.

# THE SELECTIVE SURGICAL TREATMENT OF DIAPHRAGMATIC HERNIA

By Carl A. Hedblom, M.D.

of Chicago, Ill.

Diaphragmatic hernia is a protrusion of abdominal contents through an abnormal opening in the diaphragm which results from imperfect development, anatomic weakness or trauma. Of 1,003 cases reported in the literature since 1900, nearly one-third were classed as congenital; a little more than one-third as acquired after birth; and about one-third followed trauma. Most of those of the acquired type were œsophageal hiatus herniæ.*

In each of these etiologic types there are many anatomic and clinical variations which are of much importance to treatment. The presence or absence of a sac, the position and size of the ring, and the varying hernial contents constitute important anatomic differences. The strangulated and non-strangulated hernias represent the most definite clinical types, but lesser disturbance of physiologic function, age and general condition of the patient are important factors bearing on indications for surgical treatment and on the choice of operative procedure.

As reported in the literature, a sac is present in less than a quarter of the cases of congenital hernias, in more than 95 per cent. of those acquired after birth, but is rarely present in hernias due to penetrating injury or violent blunt trauma. If a sac is present and is not incised pneumothorax does not result if the hernia is repaired through a laparotomy approach. On the contrary, if there is no sac, a pneumothorax develops through a laparotomy as well as through a thoracotomy approach.

If a congenital hernia is small the opening is most often posterior, if larger it is usually postero-lateral; if very large a sickle-like segment of the diaphragm may be found antero-laterally or there may be complete absence of the hemi-diaphragm. The predominatingly posterior location of a small opening is due to the fact that it is the site of the pleuro-peritoneal canal which is closed last by the developing diaphragm. A congenital hernia therefore typically involves the posterior portion of the diaphragm which is least accessible by a laparotomy. The opening may be too large for closure except by the aid of a plastic. In case of a sub-total or total defect a collapse of the chest wall may be a necessary preliminary operation.

Acquired hernias develop chiefly at the œsophageal hiatus, of which more than two hundred cases diagnosed röntgenologically, are reported in the recent literature. The hernia opening as a rule is small, easily approached and identified by thoracotomy but not infrequently is very difficult to expose

---

* For tables and complete bibliography see chapter on Diaphragmatic Hernia by author in Lewis' "Practice of Surgery," vol. v, 1930.

by laparotomy. The edges of the ring may be ill-defined and the œsophagus hard to identify.

There are about sixty reported cases of herniation through the parasternal foramina of Morgagni. Nearly all of them had a sac. More than half were on the right side. A hernia through one foramen may be into the opposite pleural cavity. These hernia openings lie directly under the xiphoid process and are therefore very easily approachable through a mid-epigastric incision, through which both foramina may be inspected and repaired. A thoracotomy approach, aside from the unnecessary hazard incident to a pneumothorax, necessitates transversing the anterior mediastinum in case the hernia is through the opposite foramen and does not allow inspection of other ring if the hernia sac is on the same side as ring. Therefore, hernias through the foramen of Morgagni should be repaired through a laparotomy exposure.

Traumatic hernias due to knife stab are usually small and situated peripherally or centrally. Those due to gunshot as a rule are small and may be in any portion of the diaphragm. Those caused by violent trauma are often quite large and variously situated. The muscle may be split widely and into the œsophageal hiatus; the attachment laterally may be extensively evulsed.

The content of diaphragmatic hernia varies largely with the size and position of the opening. Among 737 cases, there were seventy-two different combinations of part of the stomach, intestines, colon, omentum, spleen, liver, pancreas and kidney in the pleural cavity. A portion of the stomach alone was herniated in 20 per cent., the colon alone in 10 per cent., and the intestines alone in 3 per cent. The stomach was found in the hernia in association with other organs in 69 per cent., and the colon and intestines in combination with other organs in 71 per cent. of the cases.

A small portion of the stomach is the characteristic content of an œsophageal hiatus hernia. It is not likely to become obstructed or strangulated. Operative repair is therefore less urgent. The transverse colon is usually found in the parasternal hernia, and it is often sufficiently constricted to produce obstipation, often of extreme grade. Operation is then urgently indicated. Small traumatic hernia openings are most apt to produce obstruction of a single acutely kinked loop of herniated bowel. Large congenital or traumatic openings usually result in herniation of a large portion of the abdominal viscera. There is often considerable embarrassment of respiration and circulation in such cases, and there is a likelihood of disturbance of function of the gastro-intestinal tract from partial obstruction. Kinking and volvulus may produce complete obstruction.

Among fifty-six cases of right-sided hernias, exclusive of those at the œsophageal hiatus, a part of the liver was the only viscus herniated in eleven; in eighteen of the others the hernia contents consisted of part of the liver in various combinations with stomach, colon and intestines. If liver is the only hernia contents, as judged by röntgenogram and absence of symptoms referable to herniation of stomach or bowel, there would seem to be

relatively slight indication for reduction or repair unless enough of the liver were herniated to interfere with respiration.

Adhesions of the hernia contents are most apt to develop in the chronic traumatic type. Absence of adhesions can be determined clinically only if the hernia contents can be seen in and out of the pleural cavity röntgenologically.
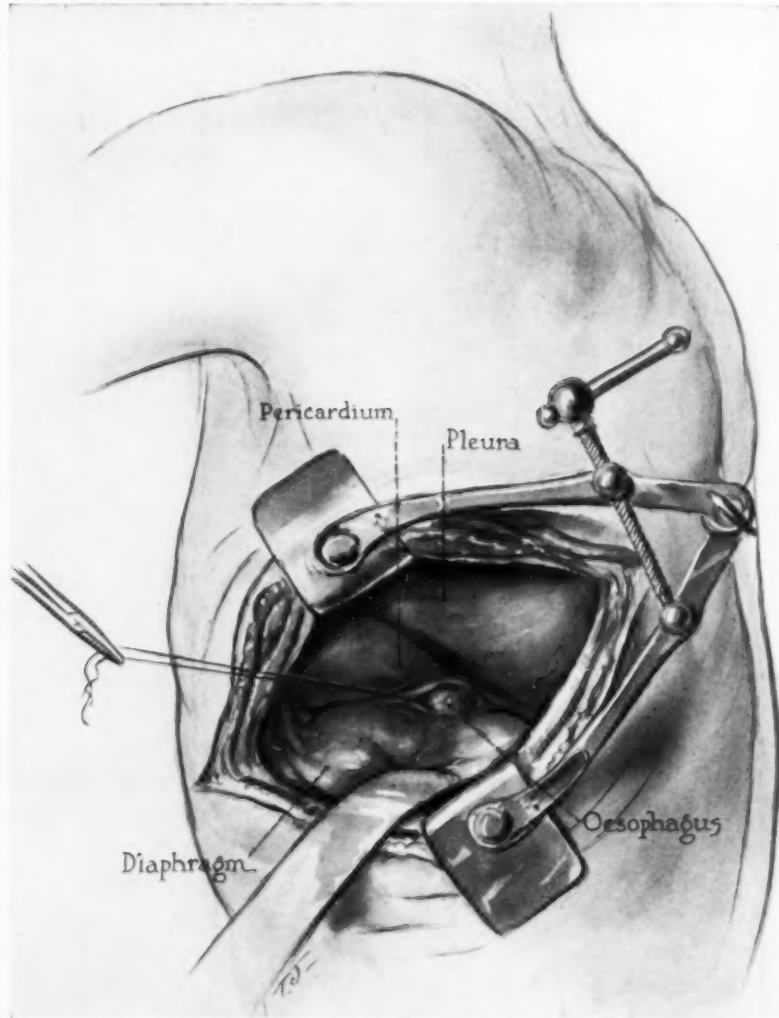


FIG. 1.—Seventh-interspace thoracotomy approach to œsophageal hiatus.

Herniation of a small part of the stomach through the œsophageal hiatus often can be produced by placing the patient in a horizontal or head-down position while under fluoroscopic examination. Such demonstration of a hernia is proof of the absence of adhesions.

Age is an important factor in consideration of treatment. Of 210 non-traumatic cases under one year of age, 158 (75 per cent.) died before the

end of the first month after birth. All of these were necropsy cases. Since serious respiratory embarrassment is often associated with a hernia opening too large for direct closure, it follows that the outlook for saving many of these infants must be slight. However, some patients with complete absence of the diaphragm reach adult age and even advanced age.

The great majority of those of acquired origin are first recognized in the middle decades; some are well past middle life.

The proportion of cases that develop strangulation varies with etiologic type. Of 476 operated collected cases, including nineteen operated upon by the author, fifty-five were of congenital origin; of which 36.3 per cent. were obstructed; sixty-four were acquired, of which 15.6 per cent. were obstructed; 145 followed war injuries, of which 47.5 per cent. were obstructed; 186 followed trauma incident to civilian life, mostly knife stab or blunt trauma, and of these 20.2 per cent. were obstructed. These figures would seem to indicate, as one would expect, that hernias through small opening in the diaphragm, exclusive of œsophageal hiatus stomach herniations, are most prone to strangulation and therefore constitute, as such, the stronger indication for immediate repair. Small knife-stab injuries, immediately repaired, lessen the incidence of civilian traumatic hernia obstruction.

The type and degree of interference with physiologic function constitute other clinical types that influence the indication for treatment. Dyspnœa and cyanosis with dextro-cardia occur particularly in infants and children with congenital hernias and at any age in presence of large traumatic hernias and may occur suddenly in any type after a large meal or following exertion. Such symptoms are urgent indications for surgical relief, but many of these patients die very suddenly before anything can be done.

Persistent vomiting or dysphagia with excessive weight loss and weakness make up a different clinical picture. Obstinate constipation with or without dyspnœa is often observed in cases of herniation of the colon through a small opening. Occasionally severe hæmatemesis or melæna with marked secondary anæmia are the striking findings. Many patients have a combination of the above-mentioned symptoms in milder degree but of sufficient severity to more or less incapacitate them.

On the basis of the foregoing it may be said that in the absence of definite contra-indications a small hernia anywhere, except at the œsophageal hiatus, should be repaired even in the absence of symptoms. A small hiatus hernia should be repaired if there are marked symptoms attributable to it. A large hernia anywhere constitutes in itself a relative indication for its surgical repair, and a definite indication if there are any marked symptoms such as described. On the same basis a small hiatus hernia not likely to become strangulated and giving rise to no definite symptoms, infancy and old age, and other conditions which materially increase the hazard of surgical treatment, constitute relative contra-indications to it.

The ideal surgical treatment is reduction and repair of the hernia open-

ing, but other procedures find their indications as emergency life-saving measures or as preliminary to repair.

The most important emergency operation is drainage of an acute intestinal obstruction. This may be by a cæcostomy, appendecostomy, colo-colostomy or enterostomy, according to the individual indications. Truesdale
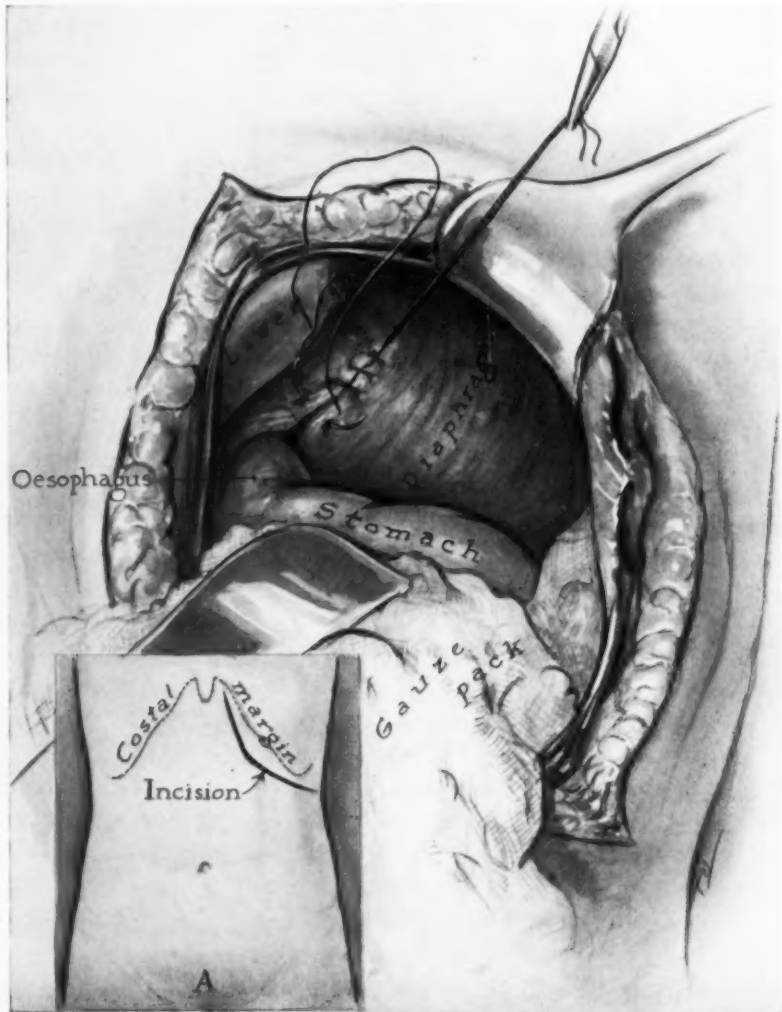


Fig. 2.—Left costal margin approach to œsophageal hiatus for repair of diaphragmatic hernia. The ligament of left lobe of liver has been cut and left lobe retracted for better exposure. Rectus muscle is split longitudinally to near the level of the umbilicus then sectioned transversely to avoid extensively damaging innervation.

has called attention to the value of dealing with an acute obstruction before attempting to repair the hernia. Several cases are reported in which all symptoms disappeared following colo-colostomy and no further treatment was necessary. If the bowel is gangrenous drainage at the site may avert a fatal issue.

Operations preliminary to closure of the hernia opening include phrenic nerve block, extra-pleural thoracoplasty and pneumothorax collapse. Of these operations the phrenic-nerve operation has by far the most important indications. The nerve may be frozen, crushed or extracted. If frozen or crushed there results complete paralysis of the diaphragm in perhaps 75 per cent. of the cases, but a partial innervation remains in the other cases due to the collateral branches that enter the trunk below the level of the block. If, however, a thoracotomy is performed, the nerve may be blocked in its course on the pericardium, which produces a complete but temporary paralysis in all cases. Extraction of the nerve is naturally followed by complete and permanent paralysis.

The advantages of paralysis of the diaphragm are relaxation which facilitates closure of a large ring, and immobilization, which makes the operation technically easier, and also favors healing.

The operation is indicated in all cases of congenital hernias, in which the opening is often both large and relatively inaccessible, and in traumatic hernias due to blunt trauma. In acquired hernias at the œsophageal hiatus the opening is usually small and only half of the ring would be relaxed. Hernias at the parasternal foramen are usually relatively small and easily accessible. Furthermore, as stated, one cannot be sure before operation that the ring is on the same side as the sac and contents. In traumatic hernias due to blunt trauma the opening is often large, and in such cases the repair will be greatly facilitated by a relaxed diaphragm. In the repair of small openings due to penetrating injuries, paralysis of the diaphragm is unnecessary from the standpoint of relaxing the ring.

Ordinarily, a temporary, rather than a permanent paralysis is indicated. Only in cases in which the closure is effected under tension during a temporary block would it seem advisable to make the paralysis permanent by extracting the nerve.

Phrenic nerve block, or extraction, as an exclusive method of treatment of diaphragmatic hernia would seem equivalent in principle to simply enlarging a ventral or inguinal hernia opening in the treatment of these conditions.

Extra-pleural thoracoplasty, consisting of resection of the whole length of the lower ribs, finds its indications in cases in which the diaphragmatic defect is so large that its edges cannot be approximated. In 1925 I suggested such an operation. It has since been performed by Carrington and by Harrington. Bettman was able to close a congenital lateral hernia opening in an infant of three months following the relaxation obtained by simple section of the lower ribs.

In case of patients with total or subtotal defect there is little or no prospect of improvising an artificial partition between the pleural and peritoneal cavities. The symptoms are due chiefly to the prolapse of a large part of the abdominal viscera. In such cases a complete posterior and antero-lateral costectomy would result in practically a total obliteration of the pleural cavity.

Pneumothorax has been advocated as a preliminary to a thoracotomy

approach for repair of a hernia. However, modern equipment for thoracic surgery includes positive pressure gas anæsthesia apparatus which largely obviates any danger from a wide open pneumothorax incident to a thoracotomy approach.

The repair of the hernia usually may be accomplished either through a laparotomy or a thoracotomy exposure. Occasionally both the pleural and peritoneal cavities must be opened to affect a reduction and repair. For this purpose separate incisions or a combined thoraco-laparotomy incision may be made. There exists considerable difference of opinion as to the relative merits of these various operative routes, as such.

The criteria on which they have been compared have been the relative technical difficulties and mortality rates.

There can be no doubt but that the identification of a hernia not previously diagnosed, and its reduction and repair is facilitated by a thoracotomy approach. Thus, in a series of 215 cases in which laparotomy was performed, the hernia opening was sutured in 129 (60 per cent.); reduced but not sutured in thirty-seven (17.2 per cent.); not reduced in thirty-three (15.3 per cent.) and not found in sixteen (7.4 per cent.).

Of 167 cases, in which thoracotomy was performed, the opening was sutured in ninety-one (90 per cent.); not sutured in six; not reduced in three and not found in seven. Of ninety-one cases in which combined thoraco-laparotomy was done the ring was sutured in eighty-one (87 per cent.); not sutured in three and not found in seven.

According to figures usually cited the mortality rate following laparotomy is much higher than following thoracotomy, but this difference seems to be due to the relatively much larger proportion of obstructed cases operated by laparotomy. Of 467 cases, 246 were operated by laparotomy with ninety-six deaths (34.9 per cent.); 132 were operated by thoracotomy with twenty-six deaths (19.7 per cent.); eighty-nine were operated by a combined laparotomy and thoracotomy and of these twenty-eight (31.4 per cent.) died. Among these same 467 cases 149 were obstructed. Of these 100 were operated by laparotomy with sixty-nine deaths; twenty-three by thoracotomy with four deaths (17.3 per cent.); twenty-six by a combination of both routes, with seven deaths (27 per cent.). There were 318 non-obstructed cases. Of these 146 were operated by laparotomy with twenty-seven deaths (18.5 per cent.); 109 by thoracotomy with twenty-two deaths (20.2 per cent.); and sixty-three by the combined route with twenty-one deaths (33.3 per cent.). It would seem probable that the patients with intestine obstruction who represented the poorest surgical risks were almost without exception subjected to a laparotomy. The increased mortality in these cases with perhaps a few exceptions would be due to the obstruction as such rather than to the operative route.

The uniformly high mortality rate following a combined thoracotomy and laparotomy is probably due in most cases to shock and an increased incidence of post-operative complications.

There exist definite indications for laparotomy and for thoracotomy regardless of technical considerations or any slight difference in mortality. A primary laparotomy is indicated in all cases of acute intestinal obstruction if there is doubt as to its cause. If the condition of the patient or the local findings are such that immediate reduction and repair is impossible, or too hazardous, the patient's best chances may lie in drainage of the bowel proximal to the obstruction as outlined above.

In case of a parasternal hernia a primary laparotomy is always indicated for reasons already mentioned. Only in case reduction from below is impossible after enlarging the ring would a secondary thoracotomy seem indicated.

Œsophageal hiatus hernias almost always have a sac. Closure by laparotomy therefore obviates a pneumothorax with the incident tendency to pleural effusion and empyema. The symptoms in case of a hiatus hernia may be due in part to other abdominal lesions such as a gall-bladder disease or peptic ulcer. Laparotomy approach makes possible exploration for such lesions. In case of thin individuals with short thoraces the hiatus is readily accessible by laparotomy.

Thoracotomy is the only approach to be considered in cases of fresh penetrating wounds of the thorax with prolapse of abdominal contents. The wound is enlarged as necessary for exposure, reduction and repair. If there is any probability of perforation or hæmorrhage from an abdominal viscus an incision may be made in the diaphragm for exploration and for adequate attention to such lesions, including splenectomy in case of extensive damage and bleeding of that organ. Thoracotomy is also indicated in chronic hernias with symptoms of partial obstruction, especially in case of chronic hernias due to penetrating injuries. In most cases the hernia ring is small and the herniated viscus is very frequently adherent to it, in which case splitting the diaphragm makes possible reduction without risk of tearing it. In obese patients and those with long narrow, rigid thorax, as in an older individual laparotomy approach to the hiatus may be exceedingly difficult. If there is much fatty deposit and coincident oozing it may be very hard to identify the edges of the hernia ring and the œsophagus. As a result, the closure may be inefficient, in which case the hernia is almost certain to recur. The ring may be closed too tightly if it cannot be clearly visualized. In one of my cases the closure was too tight and one suture penetrated the wall of the œsophagus leading to a fatal mediastinitis.

Aside from the considerations mentioned, the chief limitation of laparotomy is the difficulty or impossibility of reducing the hernia contents in case they are adherent to the inside of the thorax, and the greatest limitation to thoracotomy is the difficulty that may be encountered in reducing the viscera into the abdominal cavity. In case of a large hernia, present for a considerable time, the herniated abdominal viscera may have lost the "right of tenure" in the sense that there is no longer sufficient room for them in the abdominal cavity. Neither condition can be anticipated with certainty, but adhesions may be expected in case of spontaneously irreducible hernia of

long standing, especially of the traumatic type, and difficulty with reduction may be anticipated in obese patients and those with strong abdominal muscles as contrasted with the flabby abdomen of patients who have lost much weight, or in case of women who have borne many children.

In case a laparotomy is the primary approach and reduction is impossible, or seems unsafe on account of adhesions, the abdominal wall may be closed temporarily and a secondary thoracotomy may then be performed. Or in case no difficulty with reposition of the viscera is anticipated the thoracotomy may be deferred to a later date. Similarly, in case a thoracotomy is first performed an immediate secondary laparotomy is indicated if there is serious difficulty with the reduction of the herniated viscera from above.

There can be no doubt that a combined thoraco-laparotomy facilitates exposure to the hernia opening, reduction and repair but, as stated, the mortality has been much higher than where the other routes have been used.

Special procedures, in cases with hernia openings that it has been impossible to close directly, besides plastic operations on the chest wall mentioned above as preliminary operations, include the use of muscle and fascia for direct repair and obturating the opening with an abdominal viscus. Keller has described a method involving the use of a portion of the latissimus dorsi muscle; Truesdale has used a fascial flap and Sauerbruch has sutured the diaphragm to the chest wall at a higher level than that of its normal attachment.

In case of a thoracic stomach in which only the cardiac portion of the viscus lay above the hiatus, it may be possible to transplant this portion of the stomach to the level of the diaphragm more laterally, as was done by Hybbinette. The opening has been obturated by suturing into it the adjoined portion of the stomach or spleen. In other cases an attempt has been made to prevent the stomach from herniating by suturing it to the abdominal peritoneum and to the diaphragm. Recurrences usually follow such methods. If the hernia opening is inaccessible by laparotomy a thoracotomy should be performed at the same time or later.

A simple procedure following reduction and repair of the hernia that may be life-saving is to reduce a surgical pneumothorax to a minimum. This may be accomplished by inflating the lung with the positive pressure gas anæsthesia apparatus before the pleural cavity is completely closed or afterwards by aspirating the air. The latter can be performed best with a pneumothorax apparatus by reversing the system, using the monometer as a guide in withdrawing enough air to produce a negative intra-pleural tension equivalent to 4 to 10 cubic centimetres of water pressure. This procedure relieves the mediastinum and so the other pleural cavity of the atmospheric pressure introduced by the pneumothorax. This, plus increased intra-abdominal pressure due to the restoration of herniated viscera into the abdominal cavity may reduce the vital capacity beyond the patient's power to compensate, and may also hamper circulation greatly. Reinflation of the collapsed lung in itself increases respiratory capacity and lessens the hazard of a complicating postoperative empyema.

Respiratory failure in infants, peritonitis from intestinal obstruction and post-operative shock are the most common causes of death among patients with diaphragmatic hernia.

## SUMMARY

(1) The ideal treatment of diaphragmatic hernia is reduction of the hernial contents and repair of the ring. Practically, anatomic and clinical variations, age and general condition of the patient determine the indications for operation and largely the operative approach in each individual case.

(2) Operative procedures consist of emergency life-saving measures, those preparatory to closure, and operations for reduction and repair.

(3) Emergency measures are drainage of an obstructed bowel, or of a localized abscess; preparatory operations are phrenic nerve block or section and partial thoracoplasty.

(4) Operation for repair may be through a laparotomy or thoracotomy approach or through a combination of both. In the majority of cases the hernia may be reduced and repaired by any one of these routes. There are special advantages, limitations and indications for each, depending on the anatomic and clinical type of hernia.

(5) Special procedures for closure of large or recurrent hernias include muscle and fascia plastic operations, shifting the attachment of the diaphragm, and thoracoplasty in special cases.

(6) Differential pressure anæsthesia is essential to obviate the dangers of open pneumothorax during operation, and inflation of the lung before closing the pleural cavity or aspirating the air later to restore the normal vital capacity of the opposite lung, and to reinflate the lung on the side of the hernia.

(7) Respiratory insufficiency, especially in infants, intestinal obstruction and post-operative shock are the most common causes of death.

## REFERENCES

Hedblom, Carl A.: Diaphragmatic Hernia. A Study of Three Hundred and Seventy-eight Cases in which Operation Was Performed. J. A. M. A., vol. lxxxv; pp. 947–953, 1925.

Hedblom, Carl A.: Diaphragmatic Hernia. Lewis, D., Practice of Surgery, vol. v, W. F. Prior & Co., Hagerstown, Maryland, 1930.

Carrington, G. L.: Diaphragmatic Hernia Repair by Two-stage Operation Employing Preliminary Extra-pleural Thoracoplasty. ANNALS OF SURGERY, vol. lxxxix, pp. 512–520, 1929.

Harrington, Stuart W.: Phrenicotomy in the Treatment of Diaphragmatic Hernia and of Tumor of the Wall of the Chest. Archives of Surgery, vol. xviii, pp. 561–598, 1929.

Bettman, R. B., and Hess, J. H.: Incarcerated Diaphragmatic Hernia in Infant with Operation and Recovery. J. Am. M. Assn., vol. xcii, pp. 2014–2016, 1929.

Keller, W. L.: Massive Diaphragmatic Hernia without Diagnostic Symptoms. Am. J. Surg., vol. viii, pp. 598–605, 1930.

Hybbinette, S.: Diaphragmatic Hernia of Œsophageal Hiatus; Surgical Treatment; Case. Acta Chir. Scandinav., vol. xlv, pp. 550–557, 1929.

Sauerbruch, Ferdinand: Die Chirurgie der Brustorgane, Berlin, J. Springer, vol. ii, pp. 701, 1925.

# LATE RESULTS OF SURGICAL AND MEDICAL TREATMENT OF CHRONIC CHOLECYSTITIS

## By J. Tate Mason, M.D.

of Seattle, Washington

WE HAVE endeavored in this follow-up study to record the late results obtained from surgical treatment and from medical treatment of patients suffering with cholecystitis. In this effort we have selected those patients whose histories were written and on whom a diagnosis of gall-bladder disease was made from five to fifteen years ago. In order to draw some rather definite conclusions from this investigation, we have used a limited group of patients, selected because they were suffering from well-defined chronic cholecystitis without complications. Thus those patients with acute cholecystitis, empyema, jaundice, or carcinoma have not been included. The histories, which were written five or more years ago, have been reviewed, and questionnaires have been sent to the patients, and a number of personal interviews have been held, particularly with patients who have not received relief.

This group of patients have not been particularly benefited by the advance in the knowledge of gall-bladder disease which has been made recently. Few of these people had the aid of cholecystography, which, while not necessarily increasing our accuracy in diagnosis, is certainly a great aid in arriving at more definite conclusions. Because of our added knowledge of the factors influencing the functions of the liver and biliary passages, the immediate hospital mortality of 6 per cent. noted in this group would have been reduced, we find, had these patients been operated upon in recent years, to less than 3 per cent. We now know that a diseased gall-bladder is almost always accompanied by inflammatory changes in the liver and in the biliary ducts. A damaged liver functions best with a high glycogen reserve, and ingested glucose gives a more satisfactory rise in blood-sugar than that given intravenously. (Ravdin.) We know that jaundiced patients have a low glycogen reserve and that when they are dehydrated the liver takes up and restores the glycogen content to normal very slowly. Mann has gone further, since these observations were made, in proving that animals with damaged livers are kept alive much longer on a carbohydrate than on a protein diet. Because formerly these facts were not known, many of the patients in this group were deprived of the benefit of careful selection of the time for operation. When the liver is carrying a high glycogen reserve and when diet has been controlled to such an extent that the necessity for detoxification of protein by-products by the liver is at a minimum, the operative risk is least.

Again, any change of mechanism, whether due to hepatic cell damage or to chemical activity, which depletes the liver of its glycogen reserve increases the operative risk.

## REVIEW OF THE SYMPTOMATOLOGY OF 600 PATIENTS
### WITH CHRONIC CHOLECYSTITIS

Six hundred histories out of a series of approximately 1,500 cases diagnosed as chronic gall-bladder disease were studied in detail. There were approximately twice as many females as males in this series. Twelve hundred of these patients have had the gall-bladder as the predominating cause of trouble and 300 as a secondary lesion. The familiar saying that gall-bladder disease usually occurs in females who are fair, fat, and forty has not been true in this series except in a part of the cases, as review of these histories showed that 35 per cent. of the patients were under the age of forty and 43 per cent. of the females weighed less than 140 pounds. The average age of the patients when seeking relief was approximately forty-five years.

In comparing the histories of patients suffering from duodenal ulcer and from chronic cholecystitis, it is interesting to note that 50 per cent. of our patients with duodenal ulcer stated that the onset of their gastric symptoms occurred before the age of twenty-five, while only 22 per cent. of the patients with disease of the gall-bladder began to have symptoms before twenty-five years of age.

The approximate relative frequency of abdominal organic diseases causing dyspepsia, which was reported by Blackford and Dwyer several years ago in a study of 3,000 patients complaining of gastric symptoms, was gall-bladder disease eleven, duodenal ulcer five, gastric cancer two, and gastric ulcer one. During the past ten years our figures relative to this statement have not varied by as much as 2 per cent.

Until very recently we have considered pain as a cardinal symptom of disease of the biliary tract. A few years ago we hesitated before arriving at a diagnosis of gall-bladder disease without this as the chief symptom. In this series, localized pain or soreness of varying degrees was a common complaint, but only 18.5 per cent. gave a history simulating that of one or more attacks of gall-stone colic.

Approximately three-fourths of the patients of this series sought relief on account of chronic gastric disturbances, and in over half of these the gastric symptoms had persisted for more than ten years. These disturbances consisted first of food selection, which was the most frequent complaint. The foods most commonly avoided were those that were rich and highly seasoned, fried meats, cooked cabbage, and raw apples. The next most annoying complaint was gas and belching and a feeling of fullness in the epigastrium after meals.

*Gastric Analysis.*—The gastric analysis was recorded in 402 cases. In more than half of these patients it was found that free hydrochloric acid was absent from the gastric contents or was definitely below normal. In only 6.7 per cent. was free hydrochloric acid above normal. We hesitate in the pres-

ence of a hyperacidity to make a diagnosis of cholecystitis on a patient presenting a history of chronic indigestion.

The tabulation of the condition of the gastric acids in this series, with the number of cases and their percentages, was as follows:

98 cases in which there was no free acid............ 24.3 per cent. ⎫ 55.7 per cent.
126 cases in which the acids were low .............. 31.3 per cent. ⎭
151 cases in which the acids were medium ........... 37.5 per cent.
27 cases in which the acids were high .............. 6.7 per cent.

### THE RESULTS OF SURGICAL AND MEDICAL TREATMENT
### IN 200 CASES OF CHRONIC GALL-BLADDER DISEASE

There have been 100 surgical patients and 100 medical patients studied. It is hoped that by a comparison of the degree to which each series of patients has obtained relief after a period of at least five years, a more exact comprehension of what each method has to offer in the way of therapeutic results may be arrived at. As stated before, these cases were so selected that they represent a consecutive series of patients suffering from chronic gall-bladder disease. In the surgical group of patients it was not difficult to select this series, but the manner of selection of a comparable medical series presented more of a problem. First the records of all patients who had received a diagnosis of chronic cholecystitis were carefully studied. Those which did not have associated upper abdominal disease were classified into four groups. In Group I were placed the cases that anyone would concede to be proved diagnoses. Either the gall-bladder had been found at operation for other abdominal disease to be unmistakably pathologic, or, as was more frequently the case, a perfect history of classical gall-bladder disease was obtained. In Group II were placed those cases in which cholecystitis was obviously present, but in which actual proof such as visibility of stones or history of painful jaundice was lacking. In Group III we have placed two classes of cases: The one class consists of those patients in whom there was present at times severe abdominal pain, which, however, was either not described in sufficient detail or was atypical or else occurred acutely only once, although it was presumably biliary colic. The second class consists of those patients suffering from dyspepsia of a reflex type, but not accompanied by colic or other objective evidence of biliary disease. Finally in Group IV were placed those cases in which the diagnosis of chronic cholecystitis was made upon a suggestive history without further objective evidence of gall-bladder disease, in which, however, disease of the stomach and duodenum had been ruled out. Group IV manifestly contains the greatest number of errors in diagnosis, and consequently this group has been omitted from the study. The remaining three groups were handled separately, but, as there seemed to be no significant variations in their therapeutic results, they are combined in the diagrams to be shown and in the figures which will be given.

It must be appreciated that of these two series of cases—those treated medically and those treated surgically—undoubtedly the surgical patients were the more ill of the two. The ages were approximately the same. The fact that the late mortality was higher in the surgical group seems further to support the impression that of the two groups of patients those treated surgically were the sicker. We found that of those on whom surgical operation had been performed for gall-bladder disease 10 per cent. had died at the time of sending out the questionnaires. Of the medical series 6 per cent. had died, 1 per cent. of which deaths was due to immediate post-operative mortality following delayed biliary surgery, 1 per cent. from extra-

COMPARISON OF MEDICAL AND SURGICAL RESULTS IN CHRONIC CHOLECYSTITUS.
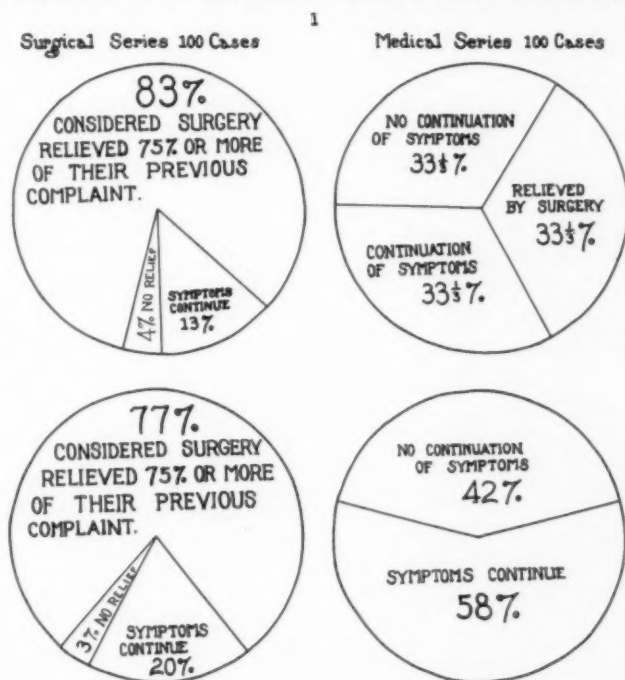


Fig. 1.

biliary surgery, and 4 per cent. from causes not determined, although in all of these cases the age at the time of death was over sixty-five years.

The medical treatment employed in the 100 cases of this series was of the simplest. It consisted almost entirely of dietary control and bowel management. Sodium acid phosphate and bile-salts were usually given, but none of the more elaborate therapeutic devices were used, such as duodenal drainage, *etc*. It is interesting to note that a majority of these patients (four-fifths) had worked out for themselves, without medical advice, a diet which excluded most of the foods which a physician would exclude in instituting dietary control. In this comparison we have tried to show by chart what this group of patients stated concerning the degree of relief of all symptoms, the

condition of digestion, the amount of gas, the presence or absence of colic, and the actual condition in regard to food selection.

The medical series studied was interesting for the fact that the patients could be divided into three groups. One-third of the patients, because of continual pain, dyspepsia, gas, and belching and in some cases because of the development of an acute condition, were operated upon. The next third continued to have the symptoms, without relief from dietary control or medicine, and should have been operated upon. The remaining third were completely relieved of symptoms following medical treatment over a period of one to six months.

DIGESTION

II

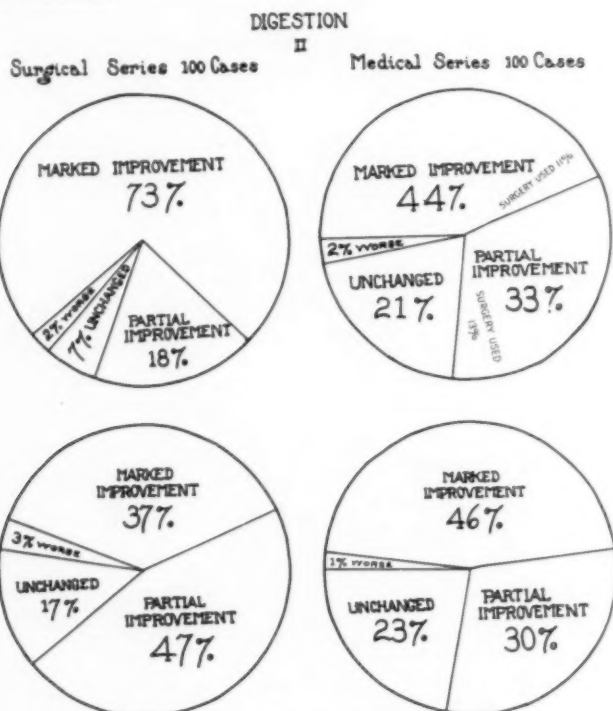Surgical Series 100 Cases          Medical Series 100 Cases



Fig. 2.

In the surgical series we find the following results: Regarding the relief of the symptom of pain by cholecystectomy, 83 per cent. considered that the operation had relieved 75 per cent. or more of their previous complaint, and 56.2 per cent. stated that they had been completely relieved of all their old symptoms. Thirteen per cent. continued to have symptoms as before, and 4 per cent. had no relief. Of the four patients who answered that they had received no benefit at all following their operation, the gall-bladder in two cases was found markedly diseased, in one case the gall-bladder was white, and in the fourth case the patient was a marked neurasthenic. In none of these cases were stones found at operation.

Dyspepsia brings more patients with disease of the gall-bladder to the physician than any other complaint. Consequently the degree of relief of

this condition is a fair index as to the benefit derived from removal of the gall-bladder. In answer to the question regarding this condition, 73 per cent. stated that their digestive disturbances were greatly relieved, 18 per cent. partially improved, 7 per cent. unchanged and 2 per cent. worse.

Gas and belching have been stated to be the most common and annoying complaint with most people with disease of the gall-bladder. After operation these symptoms were either absent (37 per cent.) or markedly relieved (46 per cent.) in 83 per cent.; no change was noted in 12 per cent.; and 4 per cent. stated that they considered themselves worse following the operation.



GAS
III
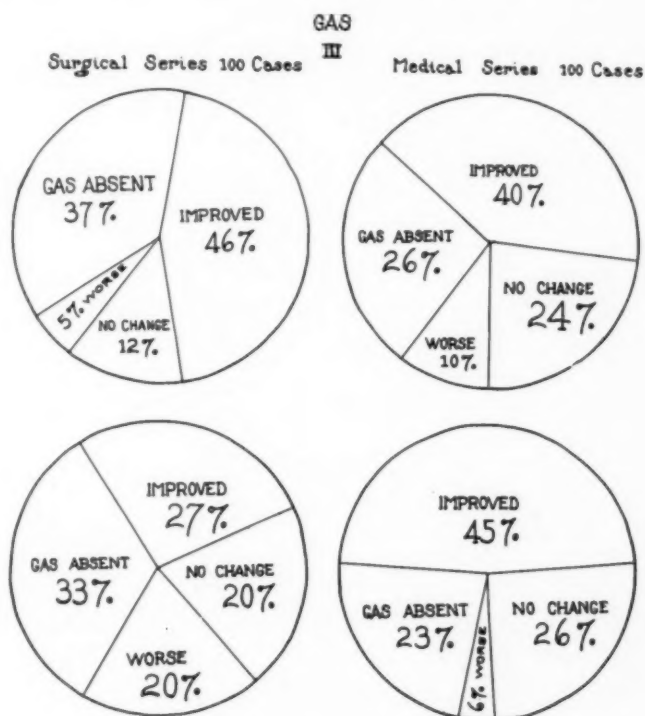
Surgical Series 100 Cases     Medical Series 100 Cases

FIG. 3.

The continued absence of free hydrochloric acid in the gastric content is the cause of the failure of some patients to receive much relief of their digestive disturbances following cholecystectomy.

Food selection is another frequent complaint, as noted above. In answer to the question as to whether or not the removal of the gall-bladder permitted these patients to eat without distress certain foods that they could could not eat before, 68 per cent. replied in the affirmative. Many patients were very emphatic in their statements relative to this question, affirming that they could now enjoy many foods which would previously have caused them great distress. Thirty-two per cent. stated that they noticed no particular difference following the operation, and only 2 per cent. felt that

they were worse in regard to food selection than they had been previous to the removal of the gall-bladder.

Colic, which is considered a common symptom of patients with disease of the biliary tract, occurred in 18 per cent. of the patients before surgical and medical treatment had been instituted. We find that 17 per cent. still reported colic after surgical treatment, but that most of these patients had only one or two attacks and these in the first year following their operation. Five years ago we were not draining the common and hepatic ducts nor investigating for stones as often as we are today. This may be the reason for this

FOOD SELECTION
IV

Surgical Series 100 Cases          Medical Series 100 Cases

FOOD SELECTION ABSENT 68%

PRESENT 32%

ABSENT 41%

IMPROVED 31%

PRESENT 28%

ABSENT 47%

IMPROVED 40%

WORSE 13%
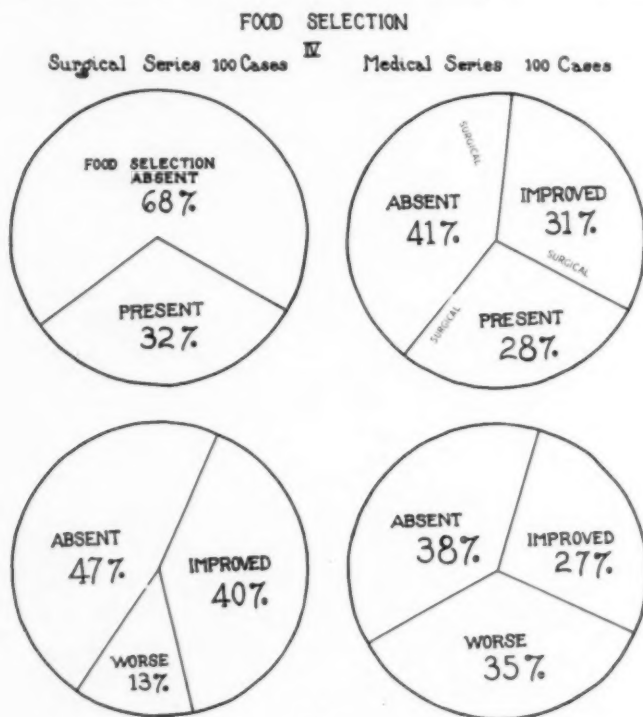
ABSENT 38%

IMPROVED 27%

WORSE 35%

FIG. 4.

rather high percentage of patients having colic following their operation. The exact cause of gall-bladder and duct colic not due to calculi has not yet been definitely established, as many of these gall-bladders and ducts did not contain stones, only 45 per cent. of the total series being found at operation to have stones.

CONCLUSIONS

(1) One-third of the patients treated medically came to operation from three to five years after diagnosis was made; one-third, because of the continuance of their symptoms, should have come to operation; and one-third under medical management became symptom free.

(2) Patients who have allowed their gall-bladder symptoms to go on for a number of years until their gastric acids have become low or absent, with

definite and permanent pathology of the liver and biliary ducts, cannot expect as complete relief following cholecystectomy as if they had received immediate operation.

(3) Approximately 30 per cent. of cases of chronic cholecystitis are relieved of their symptoms under medical management. This indicates that surgical treatment should not be advised in every case of chronic cholecystitis. We believe that a short period of medical management should be advised. If then the patient does not fall into this 30 per cent. of markedly improved patients, surgical interference should be instituted at once.
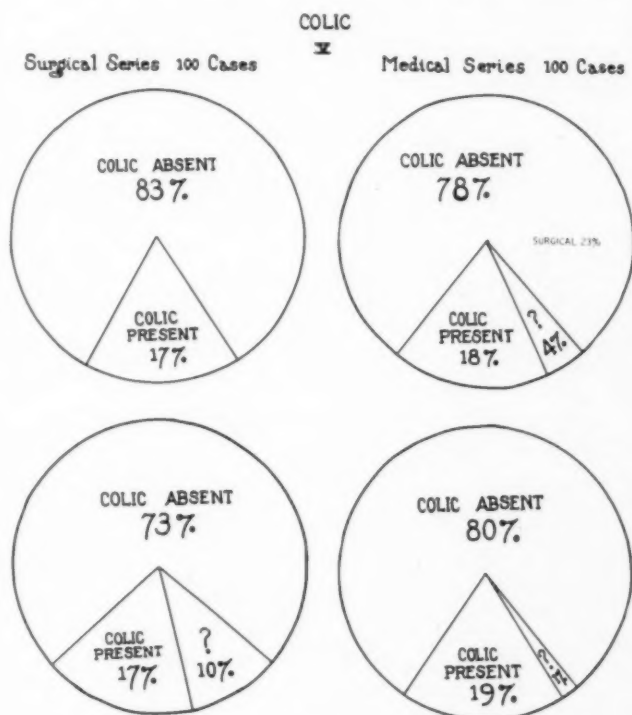


Fig. 5.

(4) The fact that 83 per cent. of those treated surgically stated that they considered the operation a cure for the symptoms for which they sought relief and that many of these cases had very little macroscopic pathology described at the time of the operation indicates that the surgeon should not be hasty in deciding against removal of the gall-bladder because of its normal external appearance when he knows that disease of the gall-bladder was diagnosed only after careful clinical, röntgenologic, and laboratory examination. The lack of the appearance of gross pathologic changes in the gall-bladder *in situ* fails to outweigh careful clinical and laboratory deduction.

(5) Those cases in which food selection is the most marked are less apt to respond to medical treatment.

# TUBERCULOSIS OF THE ŒSOPHAGUS

## REPORT OF A CASE WITHOUT ACTIVE TUBERCULOSIS ELSEWHERE

### By Franz Torek, M.D.

of New York, N. Y.

Tuberculosis of the œsophagus occurs rather infrequently, and it is still more rarely recognized. Most of the diagnoses were made at autopsies as accidental findings in patients who died of tuberculosis. In the literature no case is reported in which the lesion of the œsophagus was not accompanied by advanced pulmonary or intestinal tuberculosis. The following case is of interest because the œsophageal lesion was the only active tuberculous focus that could be found in the patient.

H. N., a man, sixty-nine years old, stated that he had never been sick until about three months ago, when swallowing became more difficult than usual. Some ten weeks before I saw him he began to regurgitate his food within fifteen minutes after deglutition. Soon after, all solid food came back immediately; even butter and fat would not go down, only milk and soup. He complained of nothing else, but he lost over twenty pounds in two months, most of it in the last two weeks. He was in the Fifth Avenue Hospital from August 14 to September 5, 1930. Röntgenograms taken there August 18 by Doctor Cole showed obstruction at the lower end of the œsophagus. In most of these pictures the end of the œsophagus looked like a blind pouch with a smooth outline, as in cardiospasm. (Fig. 1.) Doubtless cardiospasm had been present when those pictures were taken, but one of them (Fig. 2) showed the condition when the spasm let up revealing an irregularity of the outline for about one and one-half inches further down, not unlike the appearance in carcinoma. While at the hospital, his lungs were examined, and a few moist rales at both bases posteriorly were found; otherwise the lungs were clear. The probable diagnosis of cardiospasm was made. The patient was discharged with the advice to have an œsophagoscopic examination. This was made some time later by Doctor Oberrender, of the Lenox Hill Hospital, who saw a tumor resembling a carcinoma of which he removed a specimen for biopsy. The patient was referred to me by Doctor R. Donald Beck, September 30, 1930. By that time his malnutrition was extreme, and I advised him to reënter the Fifth Avenue Hospital and to submit to a gastrostomy, no matter what the pathologic examination might reveal. He was readmitted October 3, and, in the meantime, the report by Doctor Rohdenburg, director of the laboratories of the Lenox Hill Hospital, established the fact that the lesion was tuberculosis, the picture presenting a tubercle composed of a group of giant cells surrounded by endothelial proliferation which in turn was infiltrated with round cells. No evidence of malignancy was found.

On admission the patient was extremely emaciated, had extensive bed sores at the sacrum and both hips, and appeared as though he was doomed to die in a few days. Therefore, regardless of what other treatment might subsequently be decided upon, the indication for feeding him through a gastric fistula was evident.

On October 4, 1930, I performed a Witzel gastrostomy under infiltration with ½ per cent. novocaine. Through a left rectus incision an exploration was first made. A finger introduced into the hiatus of the diaphragm felt an uneven thickening on the right side of the abdominal œsophagus and the lower end of the thoracic œsophagus extending over a distance of about one and one-half inches. The feel of this was that of

tubercles, there being a number of knob-like eminences, not the more homogeneous feel of a carcinoma. The left side of the œsophagus was much less affected. In the abdomen no liver metastasis was found, no retroperitoneal lymph-node enlargement, no stomach involvement.

After the operation, the food intake at first was satisfactory, and the patient's condition plainly showed some improvement, but in the second week the patient began to lose fluid alongside the tube. When the skin sutures were removed on the tenth day, the whole wound opened, showing a total absence of any attempt at repair, just as though the operation had been performed on a cadaver. For some time attempts were made to hold the food in the stomach by tampons, also by the introduction of a larger tube, but, as time went on, these expedients proved less and less efficient, and in the fourth week it was evident that he was losing the greater part of his feedings. So, on October 29, I inserted some new stomach sutures in order to insure at least a temporary closure around the tube, but the patient died on the following day, apparently from exhaustion. Unfortunately an autopsy could not be obtained.



FIG. 1.—The contour of the shadow of this sac-like pouch is smooth, resembling that of cardio-spasm in an otherwise intact organ.

FIG. 2.—A temporary let-up of the spasm has allowed the column of barium mixture to descend a couple of inches, thereby demonstrating the seat and appearance of the lesion.

The case is of interest because of the absence of any active tuberculosis elsewhere in the body. On his first admission to the hospital the report on the patient's lungs stated that there were a few moist rales at both bases posteriorly and that otherwise the lungs were clear. Those moist rales were afterwards not found. On his second admission the interest in the case had grown very keen, and his lungs were examined by two other physicians independently of each other. Neither of these two found any trouble at the base. The first reported increased vocal fremitus and relative dullness at the right apex as compared with the left, the other reported diminished vocal fremitus on the left side. So, while they agreed that the fremitus was more perceptible on the right side than on the left, they disagreed as to which of the two sides was the normal. These three lung examinations go to show

how little the physical signs varied from the normal. The sputum contained no tubercle bacilli. After the operation the patient coughed somewhat more, but the examination of several specimens of sputum were again negative for tubercle bacilli. A röntgenogram of his lungs (Fig. 3) shows a slight haze at the right apex, on which the report was as follows: "Old fibrotic lesion in the right apex. This has the appearance of a healed tuberculous process.



Fig. 3.—A slight haze at the right apex, interpreted as possibly the seat of a healed tuberculosis.

Lungs otherwise clear." Further than this the expert opinion would not commit itself, and it seems that this opinion should be accepted, although the patient was entirely unaware of ever having been sick.

Heretofore no case of tuberculosis of the œsophagus has been recorded except in patients with advanced tuberculosis elsewhere. In this case there was positively no active tuberculosis in any other part of the body, much less an

advanced tuberculosis, and the case may very well have been one of primary tuberculosis of the œsophagus.

Another point of interest is to be found in the patient's age, as thus far tuberculosis of the œsophagus had not been seen in a patient as old as he was. As to the portion of the œsophagus affected, the case belongs to the rarer ones, as only about 12 per cent. of the cases were found in the lower third of the œsophagus.

Œsophageal tuberculosis occurs in two forms. The most common form is that of tuberculous ulcers which are irregular in outline, unlike the clean-cut punched-out ulcers of syphilis; they have a grayish base and irregularly infiltrated edges. They may present cheesy kernels, and there may be a surrounding œdematous zone. The other form is a hypertrophic sclerosis presenting itself in the shape of a tumor. (Fig. 4.)

The infection is assumed to arise through swallowing of tubercle bacilli, but it is generally believed that the un-injured mucous membrane resists infection with tubercle bacilli and that it must be abraded or otherwise injured to enable the bacilli to establish a tuberculous lesion. Evert saw one such occurrence following cauterization with hydrochloric acid; Breus, Eppinger and Kraus saw one soon after a lye burn. Another mode of invasion is from without inwards, through secondary involvement from tuberculous peri-bronchial lymph-nodes and perforation of pus and cheesy material into the lumen of the œsophagus. This kind of involvement has a tendency to heal,



FIG. 4.—Œsophagoscopic picture of a tuberculous lesion. After Guisez.

if the amount of tuberculous overflow is not too great. The resulting scar causes the well-known traction diverticulum.

The stenosis is due to a thick submucous infiltration of the wall. The muscle fibres subjacent to the lesion are in a condition of fibrous degeneration.

The œsophagoscopic picture is sometimes characteristic of the tuberculous ulceration described above, but at other times resembles that of carcinoma, especially if it is the tumor-like form. Klestadt reports such a case. To differentiate the two conditions a biopsy is often necessary.

For diagnostic purposes tuberculin has been used by Curschmann and was followed by strong general and local reactions.

The treatment is both general and local. The general treatment consists in the usual management of tuberculous patients, with invigorating diet and rest. Curschmann has employed the Rosenbach tuberculin with success in one case. For painful deglutition Lotheissen recommends swallowing one teaspoonful of a ½ per cent. solution of anæsthesin hydrochlorate. Cocaine,

alypin, stovaine, and orthoform have also been employed. Bromide, valerian and cannabis indica have been used to counteract the accompanying spasm. To the local remedies I would add the swallowing of barium paste, such as is used in X-ray examinations, which has a soothing effect. The local treatment through the œsophagoscope begins with preliminary mechanical cleansing and is followed by one of various kinds of applications, such as argentic nitrate 5 per cent., lactic acid half strength up to full strength, or iodoform. Guisez cured two cases with lactic acid. The use of radium might also be considered. Where a stricture exists, dilatation is permissible only if the ulcerations are not deep. Gastrostomy is indicated in cases of tight stenosis and in those where the analgesic treatment of the ulcers fails to enable the patient to take sufficient nourishment.

# SEVENTIETH BIRTHDAY ANNIVERSARY
## OF WILLIAM J. MAYO

Mr. President and Fellows of the American Surgical Association:

Your greetings on this seventieth birthday of mine repay me for living long enough to have it. The day in my thirties when I was elected to the American Surgical Association was the proudest day of my professional life. Each year of membership I have carried to the American Surgical Association that work which I have believed to be the best I could produce. In this connection, I wonder whether it would not be wise for the Association to choose for its Fellows more men in the thirties, with the idea of stimulating them to do their best.

Your Chairman, in his kind remarks, has forgotten the most important factor in what I may have accomplished: that is, my association with my brother. Something more than four years younger, Charlie has stimulated me by precept and example, and our association has been unique not only in the love and confidence we have for each other, but in having made an opportunity for two men to work as one and to share equally such rewards as have come. Even to this day, not only have our fraternal contacts been maintained, but also our habit of having a common pocketbook, in which each has wanted the other to have the greater share. And with due regard to the statement of a truth, my brother, Charles H. Mayo, is not only the best clinical surgeon from the standpoint of the patient that I have ever known, but he has that essential attribute of the true gentleman, consideration for others.

The years have come upon me so easily and so rapidly that I can look back on each and every one of them without regret, and I feel no older now than I did when I came into this Association. As I have watched older men as they have come down the ladder, as down they must come, with younger men passing them, as they must pass to go up, it so often has been an unhappy time for both. The older man is not always able to see the necessity or perhaps the justice of his descent and resents his slipping from the position that he has held, instead of gently and peacefully helping this passing by assisting the younger man. What pleasure and comfort I have had from my hours with younger men! They still have their imagination, their vision; the future is bright before them. Each day as I go through the hospitals surrounded by younger men, they give me of their dreams and I give them of my experience, and I get the better of the exchange. While the older man has his past, with its triumphs, too often the memories of mistakes and failures leave mental scars, which contract and shorten his vision, and as a result sometimes cause him to relinquish the profession

which is his life and try to develop new fields of interest in which he is not truly interested, and so shorten a life which is no longer stimulating.

Before stopping my operative work I visited the clinics of the younger men, and I was convinced that the older man unconsciously loses something of handicraft, something of ready response to operative emergencies. When this became plain to me I was happy to turn, in the interest of the profession that I love so well and of the patients who had been my first thought, from an active surgical career to that of surgical advisor, that I might give to the younger surgeons such of value as I had, and to the patient the benefit of my experience. I have found great satisfaction in what is a change in direction rather than a giving up of my work, in a usefulness which is as delightful as unexpected and which will satisfy me to the end.

As I see the younger men picking up the torch and carrying it on, I realize that scientific truth which I formerly thought of as fixed, as though it could be weighed and measured, is changeable. Add a fact, change the outlook, and you have a new truth. Truth is a constant variable. We seek it, we find it, our viewpoint changes, and the truth changes to meet it.

There are many recompenses in a seventieth birthday. I look through a half-opened door into the future, full of interest, intriguing beyond my power to describe, but with a full understanding that it is for each generation to solve its own problems and that no man has the wisdom to guide or control the next generation. It is a comfortable feeling, to be interested in what is to happen, but in bringing it about to be in no way responsible.